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Editorial

Withdrawal of analogue TV services

The prospect of digital TV has led various Governments and regulators to suggest dates by which the existing analogue TV services might be withdrawn. For example, in the USA, the Federal Communications Commission (FCC) has announced that all analogue TV services will be switched off in 2006. Similar proposals have been made in Germany (2007), Italy (2008) and Spain (2010), whilst the UK is considering a "10 to 15 year timeframe". [1]

Broadcasters who are introducing digital TV services would probably welcome such initiatives. Announcing a date for the closure of analogue TV would emphasize to consumers that digital TV will eventually replace analogue TV. This would have the immediate effect of depressing the sales of analogue TV sets and accelerating the take-up of digital services. This would benefit the broadcasters by increasing the availability of their new digital services and, hence, reducing the cost-per-head of such services. By reducing the period of "simulcasting" (i.e. parallel operation of analogue and digital transmitter networks), it would also help to reduce the costs for broadcasters.

However, given the uncertainties about the speed at which consumers will adopt digital TV and the fact that no digital terrestrial TV services are yet on the air, it seems premature to announce precise timetables for the replacement of analogue TV by digital TV.

Broadcasters need to understand why Governments and regulators are preparing aggressive timetables for the withdrawal of analogue TV services. The principal reason is that they are keen to promote efficient use of the radio spectrum. Demand for the radio spectrum exceeds supply in many countries. This situation is certain to get worse. As digital terrestrial TV promises a 4:1 improvement over analogue, the transition to digital TV could eventually release a very large amount of spectrum. This released spectrum could be used either for more broadcasting (e.g. more digital services, or for high-definition TV as in the USA) or for other services (such as mobile radio).

A further factor is that some regulators are attracted by the concept of using spectrum auctions to decide how spectrum should be allocated. Inevitably, the financial prospects are extremely uncertain: several "successful" bidders in the spectrum auctions in the USA have returned the spectrum "unused" to their Government. Nevertheless, many Governments will be keen to exploit any new opportunities for them to raise revenue.

Rapid take-up of digital TV would clearly benefit the consumer electronics industry but, as public service broadcasters, EBU Members must also take into account the needs of the public.

Market research in the USA [2] suggests that only about 50% of homes will have digital TV by the proposed date for withdrawal of the analogue TV services. This implies that about

1. The UK Government has issued a consultative document entitled "Digital television: the future" together with a report entitled "A study to estimate the economic impact of Government policies towards digital television". Electronic versions of these documents are available at http://www.culture.gov.uk/CONS.HTM

2. For example, in September 1997, Forrester Research predicted that *"By 2007, 49% of American households will own digital receivers and will watch digital television"*.

50% of homes will still be dependent on analogue TV. Clearly, there is a problem here: either the analogue TV services will have to be maintained much longer than the FCC expects, or the market researchers have seriously under-estimated the impact of digital TV.

It is important to be realistic about the prospects for rapid take-up of digital TV. Few consumer electronics products achieve penetration of 3% of households within 3 years and only the most successful, such as the audio CD, have reached 50% within 10 years. In the case of digital TV, there will inevitably be resistance from some members of the public who will not be able to afford digital TV equipment, or who see no reason why they should not continue to use their analogue TV sets. Even worse, it should also be noted that an increasing number of households have more than one TV set. **Every TV and every VCR** must be replaced or equipped with a digital set-top box **before** the closure of analogue TV services.

There is not much experience to guide us in determining a realistic timetable for the withdrawal of analogue TV services. The nearest parallels are the withdrawal of the 819-line services in France and the 405-line services in the UK. The latter involved a 15-year period of simulcasting, ending in 1984. It might be thought that the transition to digital TV could take place even more quickly. However, circumstances were very different then. The last 405-line TV sets were manufactured in the UK at the end of the 1960s and they used valves, rather than transistors. At that time, the “life expectancy” of such sets was about 8 years. In other words, it was surprising that there were any 405-line sets still operating in 1984. Modern television sets last much longer, with a life expectancy of 15-20 years and, hence, we cannot rely entirely on the natural replacement of TV sets as the catalyst in the transition to digital TV.

More recently, various broadcasters – especially in Eastern Europ – have made or plan to make the transition from SECAM to PAL. As most modern TV sets can receive PAL as well as SECAM, this transition should be relatively painless, except for those people with older colour TV sets.

In most countries, it is the politicians who will set the timetable for the withdrawal of the analogue TV services. Depriving the viewers of their TV services is unlikely to win many votes!

Although there are arguments in favour of setting a date for the closure of analogue TV services, this date will almost certainly need to be revised, depending on the take-up of digital TV. In any discussions with their respective Governments or national regulators, broadcasters should support a **realistic** date for the withdrawal of their analogue TV services.

My personal prediction is that analogue TV services will need to be maintained for, at least, 15 years after the start of digital TV services. But, I could be wrong!

Philip Laven

Philip Laven
Director
EBU Technical Department

The Multimedia Home Platform
– an overview

J.-P. Evain
EBU Technical Department

The Multimedia Home Platform (MHP) encompasses the peripherals and the interconnection of multimedia equipment via the in-home digital network. The MHP solution covers the whole set of technologies that are necessary to implement digital interactive multimedia in the home – including protocols, common API languages, interfaces and recommendations.

This article offers an introduction to the design and harmonization of MHP receivers, starting with a reference model which has been derived from the DVB and UNITEL reference models.

Introduction

At the beginning of 1996, the *UNITEL – universal set-top box* project was launched by the ISIS Programme of the European Commission. The main aim of this project was to raise awareness of the benefits of developing a common platform for user-transparent access to the widest range of multimedia services. Promising progress has since been achieved towards the harmonization of what is now widely called the *Multimedia Home Platform* (MHP).

The MHP Launching Group was born from the UNITEL initiative in order to open the project to external parties via joint meetings. Key representatives of the High Level Strategy Group took part in this group, and this collaboration eventually led to the transfer of these activities to the DVB Project. Two DVB working groups were subsequently set up:

- A commercially-oriented group, DVB-MHP, to define the user and market requirements for enhanced and interactive broadcasting in the local cluster (including Internet access).
- A technical group, DVB-TAM (Technical issues Associated with MHP), to work on the specification of the DVB Application Programming Interface (API).

DVB-TAM is currently considering several API candidates:

- MHEG-5 / Java;
- *Mediahighway* +;
- *JavaTV*;
- HTML / Java.

The API chosen by DVB will have to be open, in order to suit the requirements of a horizontal market. It will have to be CA-independent but will support compatibility in a multi-CA environment.

Reference model

Different reference models have been defined for each MHP system currently in use. UNITEL used object-modelling tools to define the application classes and functionalities that would ultimately identify the hardware and software resources required by an MHP system. With this system, users would be able to access:

- enhanced broadcasting services;
- interactive broadcasting services;
- Internet services.

Fig. 1 shows just a part of the UNITEL reference model which was submitted to the DVB-TAM *ad-hoc* group that is working on the system modelling.

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Manuscript received: 29/5/98.

DVB-TAM succeeded in defining a common generic reference model, which is shown in *Fig. 2*. The reference model shown in *Fig. 3* is a combination of the models shown in *Figs. 1* and *2*.

Abbreviations

API	Application programming interface
A/V	Audio / video (visual)
CA	Conditional access
CCETT	(France Telecom's) *Centre Commun d'Etudes de Télédiffusion et de Télécommunications*
CPU	Central processing unit
DAVIC	Digital Audio-Visual Council
DRAM	Dynamic random access memory
DSM-CC	(ISO) Digital storage media - command control
DSM-CC UU	(DSM-CC, user-to-user
DVB	Digital Video Broadcasting
DVB-SI	DVB - Service Information
EEPROM	Electrically-erasable programmable read-only memory
I/O	Input/output
ISO	International Organization for Standardization
JAVA	Programming language for the WWW (developed by Sun Microsystems)
MHEG	(ISO/IEC) Multi- and Hyper-media coding Experts Group
MHP	Multimedia home platform
mips	Million instructions per second
MPEG	(ISO) Moving Picture Experts Group
NIU	Network interface unit
ROM	Read-only memory
RTE	Run-time engine
TAM	(DVB) Technical issues Associated with MHP

The reference model shown in *Fig. 3* allows the development of high-level APIs and applications, independent of the MHP system infrastructure.

This model offers system modularity through the use of key interfaces. These interfaces will be able to maintain the stability of MHP systems as they evolve – both in terms of hardware and software. Backward compatibility will be supported to the largest possible extent, e.g. by using scalable applications.

Each application that is developed will need to comply sufficiently with the reference model to ensure cross-platform interoperability in a competitive envi-

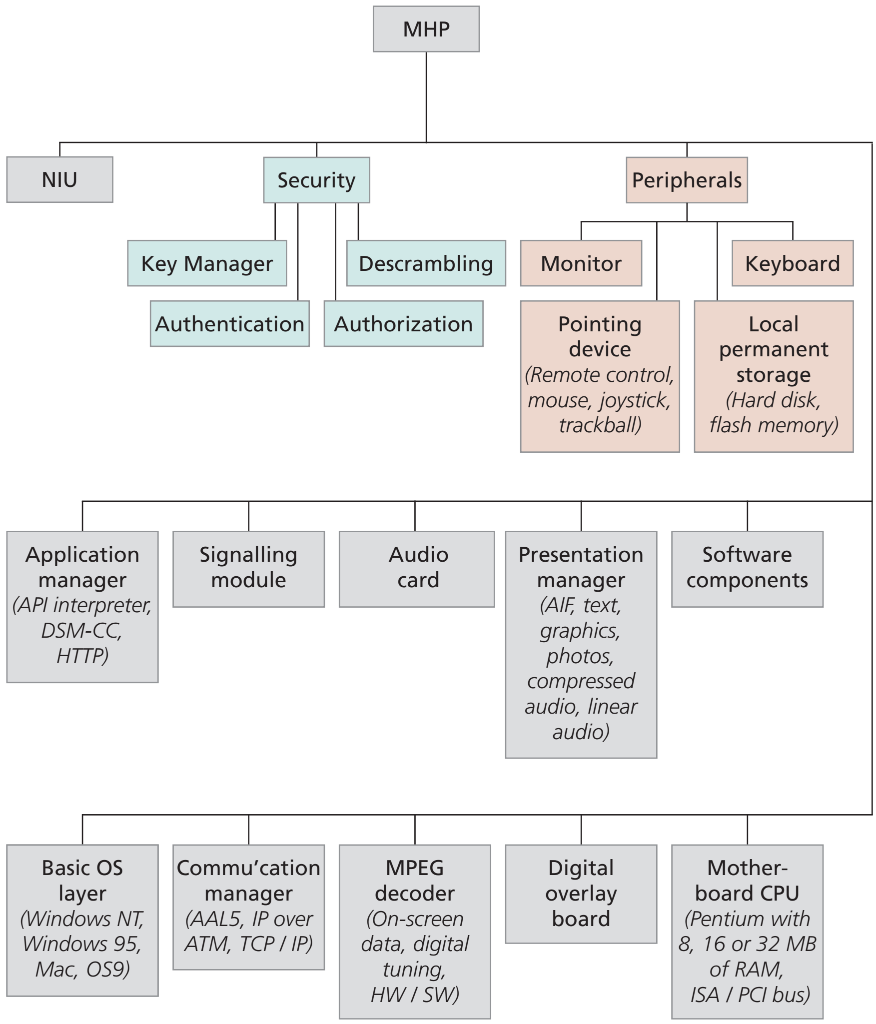

Figure 1
UNITEL: MHP hardware and software resources

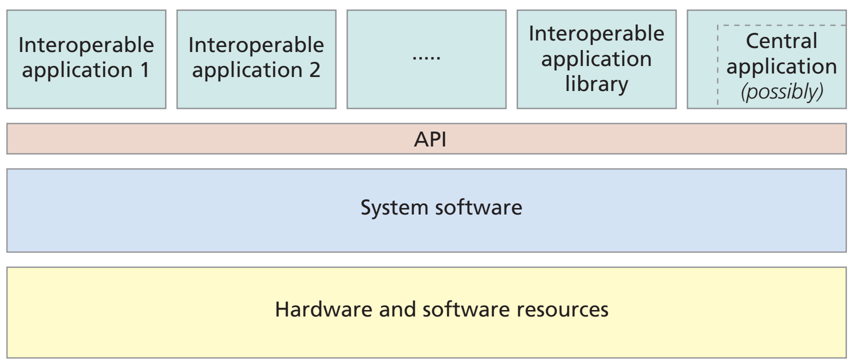

Figure 2
DVB-TAM reference model: system layers.

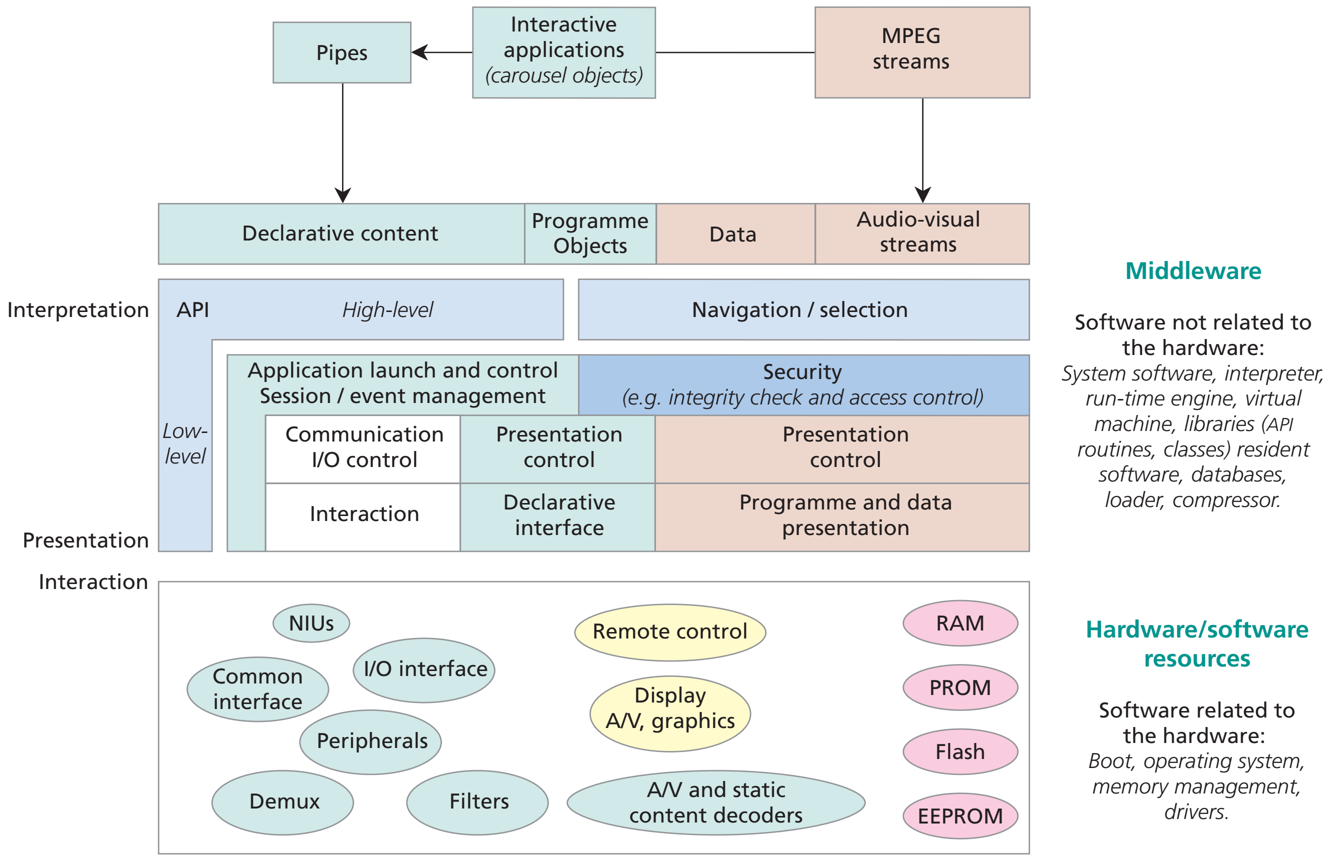

Figure 3
Reference model: a possible API and middleware for pipes and streams.

ronment. This should result in host platforms where the integrity of the application is protected, and its behaviour is stable and predictable (thus resulting in a high quality of service). The reference model must also define modes for data delivery, memory handling, object handling and instruction execution.

The reference model consists of five layers:

- application (content, script) and media (audio, video, subtitle) components;
- pipes and streams (*see Fig. 4*);
- the API and native navigation / selection functions;
- platform / system software or middleware, including the interactive engine, the run-time engine (RTE) or virtual machine, the application manager, etc.;
- hardware and software resources, and associated software.

The main system functions are:

- application launch and control, session / event management;
- security and access;
- content loading;
- navigation and selection;
- declarative content and streams presentation control;
- communication and I/O control;
- signalling, bit transport, driver and management functions.

Applications

The predictable environment described by the reference model will readily allow applications to be authored and tested. Compliance with the reference model will ensure that applications execute properly, independent of the precise MHP implementation. The integrity of the look, feel and function-

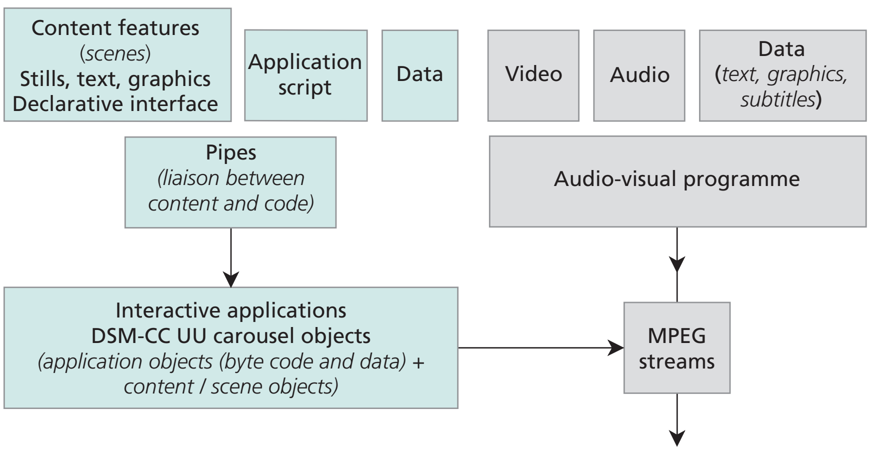

Figure 4
Reference model: application "pipes" and MPEG streams.

alities of each application will have to be ensured; the design of the original application provider must be preserved – irrespective of the platform implementation. It should be possible to design scalable applications that maintain compatibility across a range of receiver implementations.

DVB-TAM defines an application as a functional implementation of an interactive service which is realized as software modules. An application can also be seen as a set of organized functions that request activation of MHP hardware and software resources (see *Fig. 5*).

An interactive application is basically built around:

- *application script* (which can be declarative and / or procedural)
- *content/scenes* (declarative interface and media streams).

The declarative interface is the representation of the man-machine interface. It can consist of graphics such as a background design, selection buttons, still pictures, text etc. Each scene can comprise a set of other scenes, application objects and attributes. The pipes implement the interconnections between the scenes and concatenated functions.

Procedural applications, based on low-level functions and primitives, are used when very strong optimization is required at the host level (e.g. to minimize the platform footprint and maximize the use of the transmission resources). Procedural applications are generally platform-dependent and, hence, each one must be verified on the different host platforms.

Declarative applications use high-level functions and primitives. This allows us to define a platform-independent reference model which can verify whether such applications comply in terms of cross-platform compatibility and performance accuracy.

In reality, applications are neither fully declarative nor fully procedural. As an example, declarative applications can make use of procedural enhancements to improve their performance. This allows us to reduce the size of the application and to reduce its execution time by using routines written in executable code. Platform-independence is ensured by relying on embedded RTEs, virtual machines or other interactive engines. It is more difficult to achieve compliance of the compiled code routine libraries for different platforms, if they are not taken into account at the time of the platform design.

Applications are identified and signalled to indicate their availability, and an appropriate mode of access is presented to the user. Applications are launched automatically or by request. The application presentation can be nominal or down-sized (if scalable), thus maximizing the use of the available resources. Application management encompasses: interruptions, failures, priority modes and dynamic resource allocation. The application must release the system resources it has used, when quitting.

Application delivery mechanisms

Application script and content are grouped together in application objects which are converted into DSM-CC carousel objects. DSM-CC has been standardized by MPEG for the retrieval and transport of MPEG streams, and has been adopted by DVB. DSM-CC UU is the interface that allows us to extract DSM-CC carousel objects from the broadcast stream, or via an interactive access to a remote server.

DSM-CC carousel objects allow one or more application objects to be carried in one module of the data carousel. Objects can be arranged in modules, in order to optimize the performance and use of memory. DSM-CC also includes compression tools to format the application objects and carousel modules, and mechanisms to ensure the secure downloading of the carousel objects.

Definition of the API

DVB-TAM has defined an API as a set of high-level functions, data structures and protocols which represent a standard interface for platform-independent application software. It uses object-oriented languages and it enhances the flexibility and re-usability of the platform functionalities.

An application describes a set of objects according to the definition of high-level APIs. It defines the interface (via the interactive engine) between the applications, and the software and hardware resources of the host. The primitives that are embedded in the application objects are interpreted, and the resources that are requested by the corresponding declarative and procedural functions are activated. The interpreter is an executable code.

UNITEL identified the following API requirements:

- *Openness:* it should be specified in such a way that it can be used in the implementation of other interfaces.
- *Abstraction:* it should not expose its implementation. It should also hide all aspects of the underlying software and hardware.
- *Evolution:* it should be flexible and easily extendible.
- *Scalability:* it should be hardware-independent in order to take advantage of future improvements in hardware and of the characteristics of different hardware implementations. The API itself can be updated or complemented by, for example, adding new libraries (e.g. procedural extensions) by means of download mechanisms.

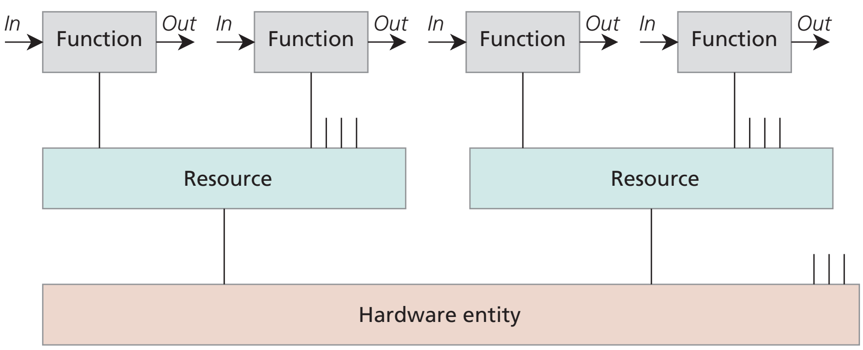

Figure 5
DVB-TAM: relationship between hardware entities, resources and functions.

According to the application format, low-level and/or high-level APIs will be used to deal, respectively, with procedural and declarative functions:

- *Low-level APIs* are more procedural and tend to access low-level procedural functions. The API interprets the application function or primitive but also knows how to activate the resources.
- *High-level APIs* are more declarative. The higher the level of abstraction declaration (i.e. the hiding of the system implementation), the stronger is the system independence. The API interprets the application function or primitive but does not need to know how the corresponding resources will be activated.

The specification of an open API should lead to the embedding of this hardware-independent facility within DVB receivers.

DVB-MHP has stated that the API should:

- support applications that are locally stored as well as those that are down-loaded in either real time or non-real time;
- preserve the "look and feel" of the application;
- enable access to databases (e.g. DVB-SI);
- allow room for competition among implementers.

An open and evolutionary (modular, portable, flexible, extendible) API is vital for the implementation of platforms in an unfragmented horizontal market. This will allow different content and service providers to share different implementations of compliant platforms.

Navigation/selection

The API can also be used by resident programmes such as the embedded navigator function that allows a first level of navigation when the receiver is switched on. APIs can also be used to manipulate streams and to enable basic functions such as channel/programme hopping or "zapping".

The navigator can also be implemented in executable code, in which case it does not need to use the API and its interpreter. In the DVB-TAM model (*Fig. 3*), the navigator has consequently been placed at the same level as the API to enable boot access to pipes and streams.

The basic navigator should:

- list all the programmes available, without discrimination;
- allow user-friendly access to these programmes by offering appropriate shortcuts (e.g. specific remote-control buttons).

Enhanced navigation can then be provided by means of electronic programme guides, possibly including such enhanced facilities as user profiles and bookmarks.

Application launch and control

The application launch function, and the application and presentation control functions, provide the facilities to run an application. The application code may be already resident in the STU or it may be obtained via a session to a remote server. After loading, the application is launched and execution is transferred to the new code.

It is the application manager's responsibility to:

- check the code and data integrity;
- synchronize the commands and information;
- adapt the presentation graphic format to suit the platform display;
- obtain and dispose of the system resources;
- manage the error signalling and exceptions;
- initiate and terminate any new sessions;
- allow the sharing of variables and contents;
- conclude in an orderly and clean fashion.

Security functions

DVB has defined the following security requirements (although the security model itself has not yet been defined):

- The API should be accompanied by a system which incorporates a common security model for the applications and data. It should enable full compatibility between the signals transmitted by the different broadcasters and content providers.
- The security model should include a description of the procedures and entities that must be put into place to support the associated secret management issues. It should be independent of CA systems. The MHP API should give access to CA functions, if and when required.

Among the important security aspects to be addressed are (i) machine protection against abusive requests for system resources (e.g. excessive demands on memory) and (ii) protection against non-authorized access to data (e.g. private data).

Middleware

The possibility of implementing the API by means of middleware is directly related to the application format (whether declarative or procedural) and the use of either low-level or high-level APIs. Each middleware implementation will be tailored for optimum use by the host platform.

There can be different ways of implementing the interactive or run-time engine which, in general, is required to support the following:

- the script and content interpreters;
- the libraries;
- the event manager (remote control and other devices, user actions, markers, timers, the handling of error conditions);
- the loader.

Depending on the API used, the RTE offers low-level interfacing with the system hardware and software resources. The RTE may call up resident programmes which can use a native platform-dependent interface to improve the system performance and to diminish the operational constraints (e.g. the size of the downloaded application objects) at the declarative application level. The RTE is executable code, adapted to each platform and aligned with the reference model.

The virtual machine can be used to emulate declarative interfaces but it is generally used to run procedural functions (e.g. complex calculations, information and text processing, data extraction) or resident programmes

that enhance the declarative interface of the application.

The use of run-time engines and virtual machines allows the API to support the platform independence of applications.

Hardware and software resources

The Multimedia Home Platform must be user-friendly. A minimum set of peripherals includes a display, a pointing device and, optionally, a keyboard and local internal / external permanent storage. The connection of these peripherals should be on a "plug and play" basis.

Internal resources in the MHP receiver include the front-end, demux, decoders, filters, a common interface, a communication interface, a CA system, memory and associated drivers.

__Jean-Pierre Evain__ graduated from ENSEA, Cergy-Pontoise (near Paris), in 1983. His first employment was with CCETT in Rennes and, in 1992, he moved to Geneva to join the EBU Technical Department as a Senior Engineer.

Currently, Mr Evain works in the EBU division called "New Systems and Services" and is a member of various BMC project groups. He represents the EBU in various international consortia and in European collaborative projects.

Concerning his MHP and API activities, Jean-Pierre Evain is the project Manager of the CEC DG3 UNITEL project. He chaired the MHP Launching Group that eventually led to the transfer of MHP activities to DVB. He launched the ICT-SB project group on MHP harmonization. He is now the Secretary of the DVB-MHP requirement group and is actively following the DVB-TAM and DAVIC activities on the API. He also represents the EBU and UNITEL in the ETSI-MTA (Multimedia Terminals and Applications) group.

DVB has currently defined three profiles. These require a minimum of 1 Mbyte of Flash-ROM and 1 Mbyte of DRAM, up to a maximum of 16 Mbytes of Flash-ROM and 32 Mbytes of DRAM, coupled with a CPU speed from 20 mips to more than 100 mips. It is sometimes specified that, for example, 70% of CPU time should be devoted to run the applications, with the remaining 30% being used for the system management.

Stored in ROM are the following:

- the API interpreter;
- the libraries;
- the run-time engine and / or virtual machine;
- the loader,
- the system tools;
- the file system;
- the firmware;
- the operating system (boot-up, memory management, task scheduler, resource identification, alarms and timers, resource locking);
- the drivers;
- the navigator.

The use of Flash memory allows a limited number of revisions to be down-loaded. Flash memory can be partitioned in order to reserve memory segments for different memory uses and, for example, to refresh selectively only part of this memory.

The applications delivered via the DSM-CC carousel are stored in RAM. RAM is also used for video / audio / data decoding and buffering, for dynamic platform management (e.g. process queues, stacks), for data, and for persistent storage of data such as application variables.

The basic system configuration and factory settings are usually stored on EEPROM (using less than 10 Kbytes of memory).

Migration and future operational issues

Migration is primarily the process by which a population of receivers based on proprietary software systems are all converted to a population of MHP receivers which use the common DVB-MHP system and, particularly, the API. According to DVB-MHP: *"the migration process will be initiated when service providers have begun to offer services in a format that is compatible with the MHP solution"*.

DVB receivers already make use of a large number of common elements including the modulation and multiplexing schemes, MPEG-2 audio and video, the DSM-CC UU interface and protocols, the Common Interface (for conditional access and other uses) and the DVB-SI.

Nevertheless, a number of elements differ between implementations:

- the mechanisms which combine application script and code, data and contents into application objects;
- compression tools;
- the format of procedural functions;
- libraries (e.g. procedural extensions, graphics);
- data carousels or other cyclic data delivery mechanisms;
- down-loading procedures and tools;
- memory allocation and management (e.g. application queues and garbage collection);
- interactivity;
- the formats of the variables;
- security procedures.

DVB has requested that, in a multi-provider / multi-application environment, the MHP solutions should be based on the separation of data. This will enable different authorized applications to use this data (if in a common data format), particularly as different applications can be implemented to accomplish the same task. It will be possible to reserve part of the data for specific applications.

At the system level, migration should be considered carefully in order to achieve the largest possible use of the DVB-TAM API. This will help to maintain receiver portability and mobility, particularly for digital terrestrial broadcasting where the limited number of programmes is another reason to support solutions which favour a horizontal retail market. The consumer will probably not invest in several receivers if the added content value is limited.

Migration will not be "easy". It will require substantial effort and collaboration, e.g. to maintain backward compatibility with currently-deployed platforms.

The wide use of a common API will raise new operational issues. There will be significant changes in the modes of operation of the service providers who, currently, target well-defined and proven receiving platforms. In order to accommodate different implementations of platforms, all using a common API, we will have to follow certain generic guidelines:

- applications will have to be down-loadable and should not rely on persistent storage when the application is not active;
- common libraries (procedural extensions, graphics etc.) and resident programmes should be embedded in order to limit the size of the application;
- application, data and declarative interfaces should be organized in accordance with common generic schemes;
- the same data carousel object format should be used, and the same mechanisms should be applied for the delivery of these objects over the streams being broadcast;
- common compression schemes should be adopted;
- similar start-up and closing application procedures should be used;
- the amount of re-inscriptible Flash memory that is available should be defined.

MHP platforms will evolve and will be able to support more complex and, hopefully, scalable applications. These may require further API extensions. Future evolution should certainly aim at increasing the degree of commonality of these system elements and procedures. This should contribute towards increasing the cost-effectiveness of the system. It should also help to increase the lifetime of the equipment.

Acknowledgements

The Author would like to thank the DVB-MHP and DVB-TAM members who patiently agreed to describe their respective systems, and also Philippe Bridel (France-Telecom / CCETT) who developed the UNITEL architecture and reference model.

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EBU Technical Review, No. 275, Spring 1998.

Georges Hansen
1909-1998

The EBU has the sad duty of reporting the death of Georges Hansen, former Director of the EBU Technical Centre, on 21 February last.

Mr Hansen became Director of the EBU Technical Centre in Brussels in 1956 and remained in that post until his retirement in 1974. The 18 years of his directorate were marked by an uninterrupted development of the technical activities of the EBU. This work – with increasing international co-operation – gradually extended to cover every aspect of sound and television broadcasting. In particular, the rapid expansion of Eurovision and the research work undertaken in the areas of colour television, satellites and digital technology owed much to his personal commitment, professional competence and dynamic personality.

Georges Hansen was a distinguished member of a number of professional associations and was awarded the Gold Medal of the Royal Television Society in 1972 for his noteworthy contribution to the development of television. He was a Commander of the Order of Leopold, and held a large number of Belgian and foreign decorations.

MHEG-5 and Java
– the basis for a common European API?

A. Mornington-West
ITVA UK

The use of different proprietary APIs in digital television receivers is leading to a fragmented market in which the consumers are losing out, while the broadcasters battle to achieve exclusive ownership of a primary gateway to the viewer.

The Author stresses the need for an open universal API and describes how this could be achieved using the MHEG-5 content decoder in conjunction with a Java-based Virtual Machine layer. He also describes a way forward to enable a practical migration from the use of existing proprietary APIs to the use of a single universal API.

Original language: English
Manuscript received: 17/3/98.

Introduction

The digital television receiver can produce more than just sound and pictures – provided there is some way in which it can be sent additional instructions. These instructions may either be in a form which the receiver can execute, or in the form of content which the receiver can present to the viewer (or listener). Application instructions are written in the language of the specific *application programming interface* (API) which is installed in the receiver.

The use of different proprietary API products has flourished in the short lifetime of digital TV broadcasting (where the API has to satisfy somewhat differing requirements to those found in the PC environment). This has led to a situation where applications[1] that have been devised for one group of receivers cannot be executed by another group. It has also prevented those receivers associated with a particular service provider from being fully useful when using the services from a competing service provider.

While proprietary APIs have undoubtedly helped the launch of digital TV services, they have allowed private broadcasters to determine the features of the receivers which they subsidise, in order to gain a strong if not monopolistic share of the market for digital television broadcasting. Such a strategy will inevitably produce a fragmented market in which the consumer will be the loser as the broadcasters battle to win ownership of a primary gateway to the viewer.

A more beneficial approach would be to use a *universal API*. In this scenario, manufacturers would be able to concentrate on developing the market for receivers which implement a range of enhanced features for which the consumer would be willing to pay, whilst the broadcasters would be able to focus on the delivery of attractively-priced services which appealed to all the consumers.

Why do we need an API?

The composition of software-oriented products can be viewed in terms of *layers*. Each layer provides a suite of functions and provides a service to the layers above and below it. In a well-organized software environment, there should be no reason for processes in any one layer to bypass another layer in order to carry out a function. The most commonly-quoted model is that of the *Open Systems Interconnection (OSI) seven layer model*. Although not all software-oriented products can be mapped onto this model, the concept does help us to visualise the structure of many software-oriented products.

Using this model, the API in a digital TV receiver provides a predictable buffer layer between the hardware and the user-oriented executable applications (*Fig. 1*).

1. In this article, "application" is used in the same sense as in the computer environment. It is taken to mean the total package of *executable content* (or instructions) and *visual/audible content* which together make up the multimedia programme.

Abbreviations

ADSL	Asynchronous digital subscriber line
API	Application programming interface
CA	Conditional access
DAVIC	Digital Audio-Visual Council
DVB	Digital Video Broadcasting
EPG	Electronic programme guide
ESG	Event schedule guide
HDTV	High-definition television
HTML	Hyper-text markup language
I/F	Interface
IEC	International Electrotechnical Commission
IHDN	In-home digital network
IPR	Intellectual property rights
IRD	Integrated receiver/ decoder
ISO	International Organization for Standardization
JAVA	Programming language for the WWW (developed by Sun Microsystems)
LMDS	Local multipoint distribution system
MHEG	(ISO/IEC) Multi- and Hyper-media coding Experts Group
MMDS	Multipoint microwave distribution system
MMI	Man-machine interface
OSI	Open systems interconnection
RTOS	Real-time operating system
SI	Service information
STB	Set-top box
VM	Virtual machine

The hardware drivers for the decoder chips in receiver are usually provided by the semiconductor manufacturers, as detailed specialist knowledge is frequently required in this domain. In some designs there is a *Virtual Machine* (VM) layer which can provide isolation from the detail of the core processor used in the receiver design.

Applications which can be written include the basic man-machine interface (MMI) to the receiver and its remote control. The EPG is the most common example of an application which has been written for receivers and it can, in principle, be implemented as a fixed application, or as an application which is provided by or updated by the broadcast signal. Some receivers have access to a modem and this can be used to provide a return channel for the consumer to interact with remote sources of information. At the present time, the principal use of the modem has been in conjunction with the conditional access (CA) control system which many receivers use.

The use of a VM layer offers a way in which the API can become independent of the host processor. The features offered by a VM differ from one design to the next. Some designs include full checking of the address range to which an application should have access; they will report an error if this boundary is exceeded.

Some diagrams of the OSI model omit the real-time operating system (RTOS), although this process is always required.

The API can provide a reliable interface: applications can be written for it without the programmer having to know precise details of the hardware design of a particular receiver. As a consequence, it should be possible to state confidently that an application which executes faultlessly on one model of receiver should execute as reliably on a different model, provided that the API is the same.

In practice there appear to be two reasons why application download is often associated with the CA system. The first is simply that it is not usually in the commercial interests of one broadcaster to allow a competing broadcaster to have unbounded access to receivers which he may have subsidised. The second relates to the fear that a rogue application could modify the behaviour of receivers in an unwanted manner and that this, in turn, could result in dissatisfied viewers or expensive service calls.

Both of these reasons need to be addressed if an open market for unsubsidised receivers is to be established. There should be no requirement which demands that specific proprietary features are implemented. Thus, there should be no need to rely on the use of a CA system. An open API could offer the consumer a wider choice of receivers, provided that all services which could be received were interoperable.

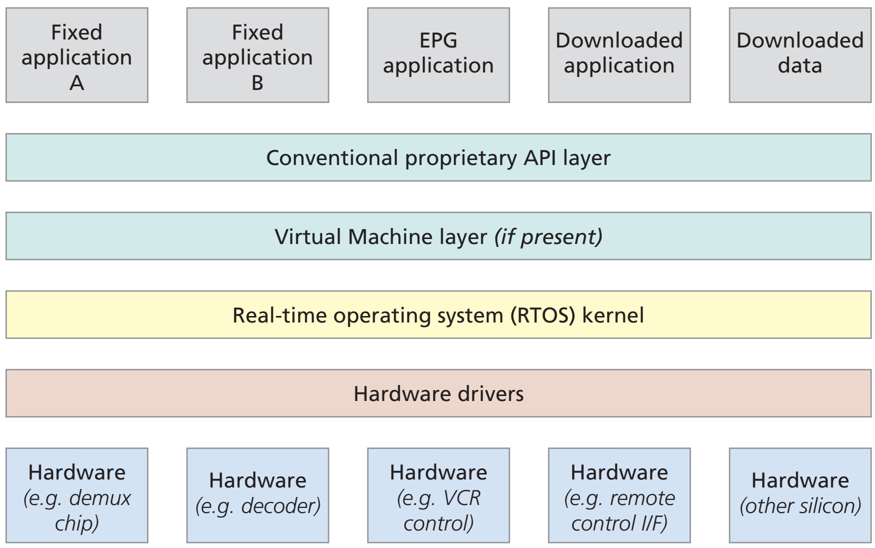


Figure 1
Layered software model of a digital TV receiver employing a proprietary API.

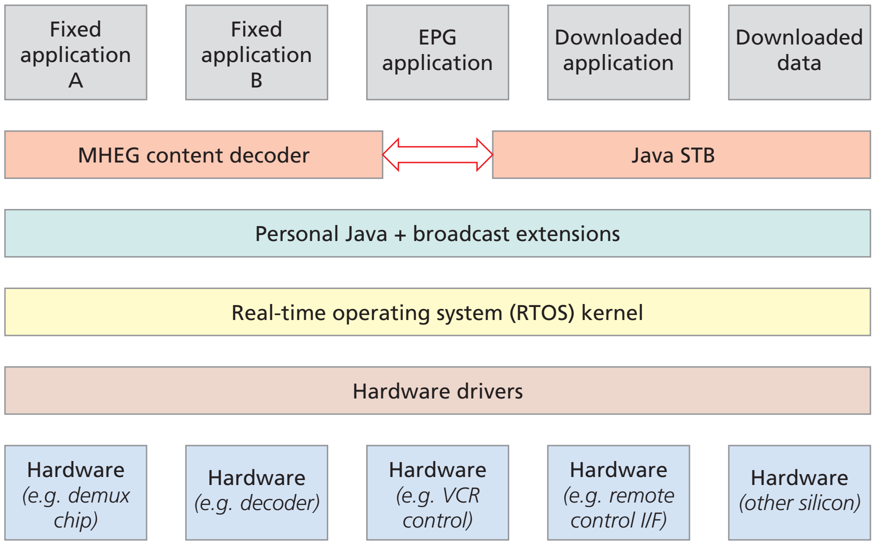


Figure 2
A layered model of a digital television receiver with DAVIC 1.5 components.

To assist in the target of protecting the receiver from the effects of a rogue application, a robust and arguably secure VM needs to be specified.

We can draw a distinction between two classes of API. The first, which we call *declarative APIs*, focus on processing the content of data for the consumer. Obvious examples include HTML browsers, MHEG and even the world standard teletext system. They are characterized by their emphasis on the decoding and presentation of data content in a uniform and consistent manner. One feature of content decoders is their robustness, and this reliability is certainly valuable if viewers are to be saved the problem of learning where the reset button is located!

The second group comprises the more conventional *procedural APIs*. These APIs make available to the programmer the full panoply of conventional computer language constructs. One problem area here is to ensure that all models of receivers from a wide range of manufacturers implement the API in exactly the same manner, in order to ensure that any application which is executed will behave in a predictable manner. This can lead to the expensive practice of having to forward the receiver to the owner of the API for conformance testing. It can also slow down the development of applications.

MHEG-5 content decoder

The origins of the MHEG philosophy started within work initiated by DAVIC. The target was to create a content decoder which would intrinsically be aware of the principal characteristics of the digital television system. It would therefore offer:

- awareness of all digital television systems;
- awareness of the pixellations that are available in the DVB bitstream;
- awareness of the video and audio content;
- the ability to link textual and graphical data with specifically timed events;
- a deterministic method of presenting the text blocks and text flow, using a subset of the suite of HTML tags to control the text formatting.
- a suite of MMI tools which could be used to provide the viewer with selection buttons and sliders for actions such as level control, character entry and screen navigation.

MHEG-5 was developed in order to support the distribution of interactive multimedia applications to executing platforms of different types and of different brands. The bulk of the code is declarative but there are provisions for calling procedural code as required. Naturally, the receiver will need to have a run-time interpreter which can process the commands as they are delivered over the air.

DAVIC has produced a suite of specifications which incorporate the MHEG standard. Each of them builds on the previous versions in a compatible manner.

- *DAVIC 1.0* was published in January 1996. It provided a set of tools to support basic applications such as TV distribution, near-video-on-demand, video-on-demand and simple forms of tele-shopping.
- *DAVIC 1.1* was produced in September 1996. It added tools to support basic “Internet compatibility”, the addition of microwave broadcast networks (MMDS and LMDS), set-top units that are network-independent and set-top units that can behave as virtual machines.
- *DAVIC 1.2* was released in December 1996. It included some tools to enable TV networks to provide Internet services at high speed to television and PC users, and also defined the HDTV formats and systems for conditional access.
- *DAVIC 1.3* is the current version, dating from September 1997. It has added: comprehensive Service and Network Management; multiple broadcast servers; mobile reception; scalable audio; content and meta-data packaging; Java APIs for DVB service information, and a new concept of *contours* – the first instances are the *Enhanced Digital Broadcast* contour and the *Interactive Digital Broadcast* contour.

Work on *DAVIC 1.4* continues and a *DAVIC 1.5* version is expected to be released in December 1998. Among the features which are expected to be added in versions 1.4 and 1.5 will be: the addition of the Java API; MHEG5-resident programs to access the DVB Service Information (DVB-SI), and further integration of the DAVIC and Internet content. The size of the DAVIC specifications means that use will be made of the contours concept; features will be carefully selected from the full feature set, in order to suit the required functionality of the receiver and the cost of developing the software.

The combination of the MHEG-5 content decoder and the Java API is represented in *Fig. 2*.

This diagram suggests that the proprietary API layer can be removed and this may be the case for receivers marketed in some regions. There is obviously scope for both MHEG and Java to be

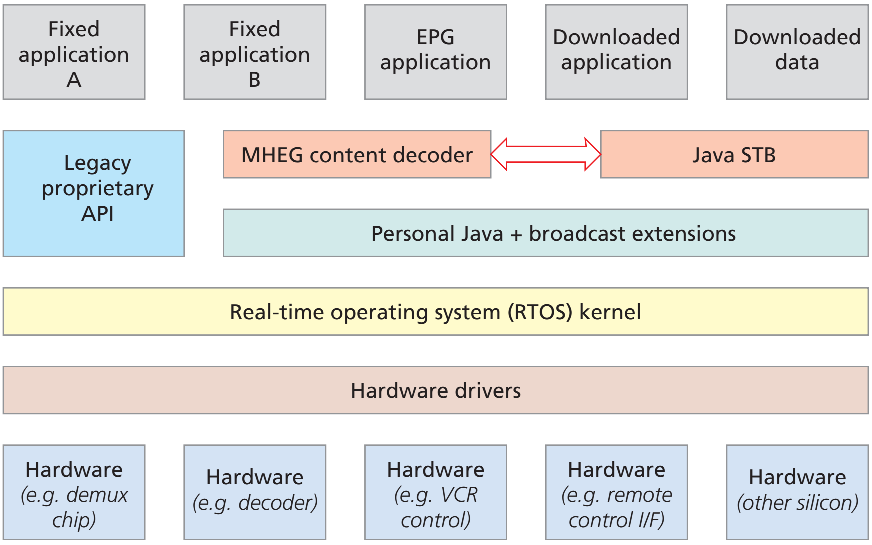


Figure 3
An intermediate state in which a legacy proprietary API may co-exist with MHEG-5 and Java.

either resident in the receiver or transmitted over the air (so-called *airware*). One use of a resident MHEG-5 application would be to provide the essential features of an event schedule guide (ESG). This is a guide which is based on the use of published DVB-SI data tables.

MHEG is an object-oriented environment in which successive scenes can be joined together to construct the overall application. Objects in a scene may include graphics, sound or video, as well as the ability to respond to local actions such as key presses. MHEG does not specify exactly what form a remote control or other input device should take; it simply specifies the functions which shall be provided, irrespective of the approach taken.

Only one application may be active at any one time although the *ingredients* which are referred to in a scene will be available to other active scenes. The ingredients include:

- links;
- procedures;
- palette;
- font;
- variable.

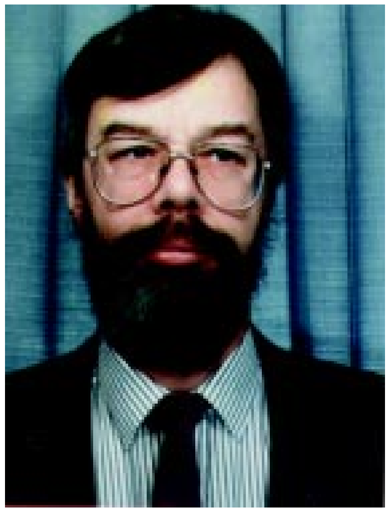
The ingredients are fairly self-explanatory; for example, a *link* provides a facility for handling the choices which a viewer might make, while *variable* indicates some storage space that can be used to pass values to and from procedures and other MHEG objects. These objects are grouped into classes and an important one is the *visible class*. It implements the presentation of displayable objects – such as line art, video, text, sliders and buttons – on a screen.

The route to migration

The inclusion of the Java VM into the specification is significant. It provides digital TV receivers with two key benefits. The first is a definition of a *processing engine* which, as far as any application need be aware, can be independent of the actual hardware processor which has been chosen by the manufacturer, i.e. receivers from different manufacturers should perform in the same way. The second benefit provides *reliability*, because the VM has been defined in order to protect applications from interfering with each other or with the background operating system processes.

The DAVIC standards set out to use existing public standards where possible. A public standard is not necessarily free of the costs of paying for any associated intellectual property rights (IPRs). DAVIC includes such standards as required, provided that any IPR is agreed to be made available on fair and non-discriminatory terms. The Author believes that the current status of MHEG-5 is such that there are no IPR fees which need to be paid and this is part of its attraction to digital television receiver manufacturers (the licence royalties for proprietary APIs can be significant). Of course, the other attraction is that a single API means that the development work can be amortised over a much larger market and this too will help to reduce the costs.

Interoperability of digital STBs has been elusive – sufficient at least to prevent any service operator from having the confidence to place orders for an integrated receiver / decoder (IRD). It seems likely that the next major growth phase in the market for digital television requires the implementation of standards such that the consumer can rely on true interoperability, not only of the primary video and audio signals but also



Allen Mornington-West *graduated from Durham University in north-east England many years ago and spent his formative years designing audio mixing desks, audio effects units and audio power amplifiers for a number of manufacturers. A period of some 8 years was spent at the Independent Broadcasting Association, working in the areas of quality control and measurement practice within the independent television companies.*

More recently Mr Mornington-West held the post of Engineering Director, Quad Electroacoustics, until the challenge arose to assist the Independent Television Association to enter the digital television era.

Allen Mornington-West is a Chartered Engineer, an MIEE and a Fellow of the Institute of Acoustics. He has been active in standards work, including assisting the professional audio and video product-family EMC standards, and the AES 24 communication standard. He is currently working in various ITU-R, EBU, DVB, DigiTAG and UK DTG working groups, some of which he chairs. He is a regular presenter of papers at UK and European conferences and he frequently lectures and writes articles.

of all the further signal components which may be present. The most heralded of these are the signals for data services, as these provide digital receivers with their full scope for interactivity.

Expansion of this market, and of the whole gamut of products which could be produced for the in-home digital network (IHDN) environment, is unlikely to take place until there is a uniform API. This is perhaps the last step to removing all the individual proprietary technologies that are found within today's receivers. These technologies result in design implementations which do not enable full interoperability, even within the same country!

Fig. 3 shows one of the many scenarios in which current proprietary APIs may still be used within receivers in the future. One use for the legacy API would be to provide an interpreter for the MHEG content. This may provide a slower performance but it may still provide a reliable product which can be delivered relatively quickly to the marketplace.

Some legacy applications could be supported for the full lifetime of the STB and this may involve the service providers in sending application content for both the legacy receivers and the new receivers for a number of years. This would only be feasible where the cost of such "double illumination" with *airware* was cost-effective.

These concerns have formed the background for the work of the DVB multimedia home platform (DVB-MHP) group (see the article starting on *Page 4* [1]). The key requirement is to chart a migration path so that receivers which are due to be introduced to the market – and perhaps those which may already be on the market – can be adapted to conform to an agreed uniform API.

At the present time this work is still in progress although it should be noted that the emphasis now is on a solution based on MHEG with a Java VM. This approach is strongly supported by a number of receiver manufacturers and by many broadcasters – particularly those planning to introduce terrestrial digital television services.

DVB shows COFDM HDTV via DVB-T at NAB-98

The European DVB Project demonstrated HDTV at NAB-98. This was the first time that the DVB-T multi-carrier "COFDM" modulation system, carrying HDTV programme material, had been shown in the United States.

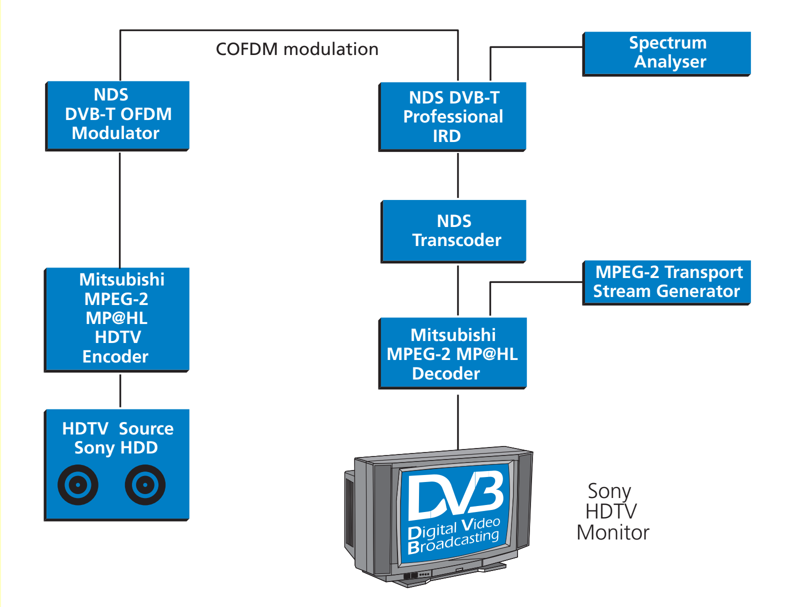
The capacity to deliver high-definition television – with cinematic-quality images and sound – is one of the principal benefits of digital television. Digital television systems also allow the possibility of carrying multiple SDTV or EDTV (widescreen 16:9) channels, or even multimedia data. All of these options need only the bandwidth of a standard analogue TV channel.

Although the different US, Japanese and European digital terrestrial systems all make use of the same MPEG-2 options for compressing their images, there are considerable differences in terms of modulation, sound coding and service information. This means that countries outside Europe, Japan and the US have a tough choice to make. Each system requires a different implementation strategy.

Broadcasters will be happy to know that, irrespective of the modulation standard they choose (ATSC 8-VSB, DVB-T COFDM, or the NHK proposal, DiBEG), the manufacturers will be able to deliver MPEG-2 HDTV and SDTV encoding equipment which is compliant with the choice of modulation technology.

The international consensus to use MPEG-2 for encoding the digital TV images makes it possible for global manufacturers to market their solutions world-wide. The resulting economies of scale can only bring the cost of new digital receivers down, for the benefit of consumers.

An unexpected star of the DVB HDTV demonstration was a $15 Radio Shack portable (set-top) antenna, which effortlessly received the low-power transmissions across the DVB stand. With this piece of "appropriate" technology, DVB showed that it is the only Digital Terrestrial Television Broadcasting (DTTB) standard which can bring digital television to a conventional, domestic, reception environment.



Overview of the DVB HDTV demonstration at NAB 98.

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EBU Technical Review, No. 275, Spring 1998.

Transparent concatenation of MPEG compression

N. Wells
BBC Research & Development

The techniques described here allow the MPEG compression standard to be used in a consistent and efficient manner throughout the broadcast chain.

By using a so-called "MOLE" which is buried within the decoded programme material, it is possible to concatenate (i.e. cascade) many MPEG encoders and decoders throughout the broadcast chain – without any loss of audio or video quality.

The described techniques have been developed in the ATLANTIC Project [1] which is a European collaborative project within the ACTS framework.

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1. Introduction

The MPEG compression standard[1] will be used for the distribution of many new digital TV services. Also, MPEG compression is already being used for contributions into the studio, because of bandwidth / bit-rate restrictions on some incoming connections. In addition, there will be pressure to use high levels of compression in future TV archives in order to give on-line access to thousands of hours of programme material. MPEG-2 compression would be a sensible choice for such archives as this standard gives a video compression performance which is difficult to improve upon, given the likely requirements for quality and bit-rate, and for the broad range of picture material to be archived [2].

However, once the signal has been compressed into MPEG form, it becomes difficult to perform operations on the signal of the sort normally encountered along the production and distribution chain. For example, it is not possible to edit or switch simply between two MPEG bitstreams without causing serious problems for a downstream decoder. Ideally, we would like to be able to handle and operate on the compressed signal in just the same way that we handle the PAL / NTSC signal today. Inevitably, this requires that the signal is decoded before being passed through "traditional" mixing or editing equipment and then re-coded at the output of the process. Then, however, more than one generation of compression has been applied to the signal. Along the complete production and distribution chain, it is likely that the signal will undergo several generations of decoding and re-coding. With multiple generations of compression, the picture and sound quality can degrade very rapidly as the number of generations increases.

This degradation of quality can be avoided by intelligent re-coding or "cloning" of the MPEG signals after decoding. The techniques described here open up the possibility of MPEG being used for post-production and all stages of distribution at bit-rates little different from those used for the final broadcasting stage.

2. The production chain

A simplified model of a typical programme production and broadcasting chain for a future MPEG digital TV service is shown in *Fig. 1*.

1. In this article, "MPEG" is used to mean MPEG-2 MP@ML video compression and MPEG-1 Layer II audio compression.

Within the studio of *Fig. 1*, a single programme is assembled from local sources and possibly from archive or satellite contribution material that has already been coded in MPEG form. Programme assembly will involve switching, mixing and editing of the various contributions. This can only be realistically achieved by working with uncompressed / decoded signals in the standard studio format, since it is important to be able to mix between material that exists in a number of different source formats (e.g. tape, servers, live inputs etc.). At the output of the studio, the final programme will be assembled and compressed to MPEG form with the inclusion of several elements in addition to the main audio and video components. These elements might include subtitles (closed captions), multiple sound channels and references to Web pages etc. All associated signals and data are synchronized with the main audio and video components via the MPEG syntax.

Abbreviations

ATM	Asynchronous transfer mode
CBR	Constant bit-rate
CRC	Cyclic redundancy check
DCT	Discrete cosine transform
DSM-CC	(ISO) Digital storage media command control
EDL	Edit decision list
ETSI	European Telecommunication Standards Institute
GoP	Group of pictures
HDTV	High-definition television
IDCT	Inverse discrete cosine transform
ISO	International Organization for Standardization
IT	Information technology
JPEG	(ISO) Joint Photographic Experts Group
MAP	*Maximum a-posteriori*
MCP	Motion-compensated prediction
MPEG	(ISO) Moving Picture Experts Group
PCM	Pulse code modulation
PES	Packetized elementary stream
SMPTE	(US) Society of Motion Picture and Television Engineers
TCP	Transmission control protocol
VBR	Variable bit-rate
VLC	Variable-length coder
VLD	Variable-length decoder
VTR	Video tape recorder

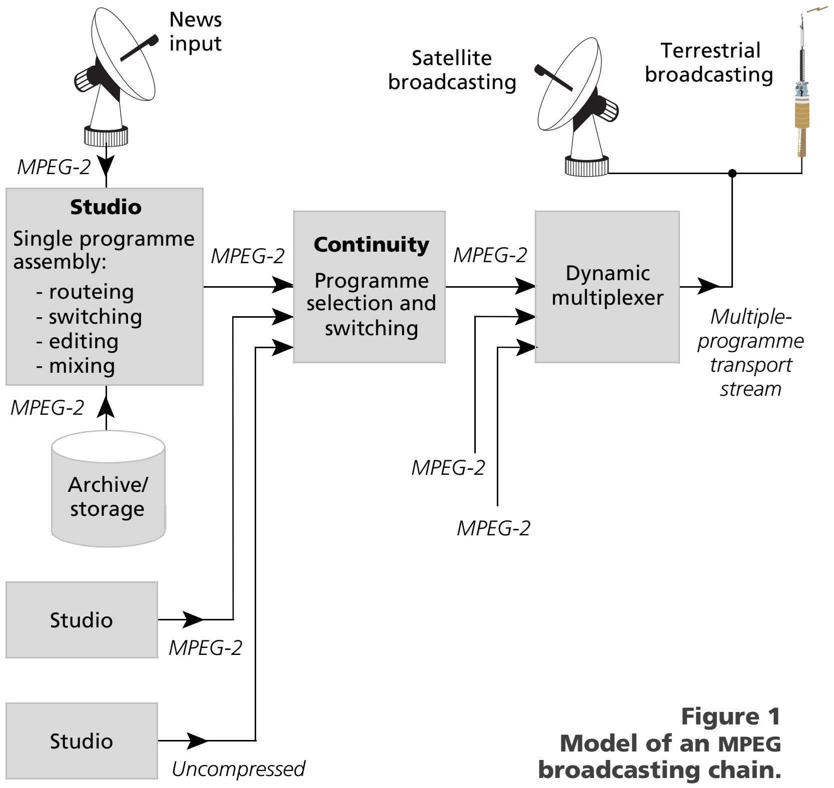

Figure 1
Model of an MPEG broadcasting chain.

The Playout or "Continuity" Centre shown in *Fig. 1* is responsible for ordering and scheduling the output of a given network channel, and for adding links and inserts between individual programmes. The most convenient format for the input bitstream to Continuity will probably be MPEG because of all the additional components associated with a given programme. However, programmes may be delivered to Continuity in many different compressed and uncompressed formats. Again the only feasible way to switch and mix between different programme material is in the decoded domain. After Continuity, the continuous channel output will be compressed into a continuous MPEG bitstream for multiplexing together with other bitstreams into a multiple-programme stream.

The final channel output may be distributed over more than one network (e.g. satellite and cable) and there may well be a requirement to change the bit-rate of the signal in accordance with the requirements of each separate network. In order to change the bit-rate of an MPEG signal in an optimum way, some degree of decoding and then re-coding is required.

In addition to the elements shown in *Fig. 1*, there could well be a requirement for the insertion of local programmes into a nationally-distributed bitstream. In this case, one programme item is removed from the national multiplex and is replaced by a locally-derived programme item. This effectively repeats the "Continuity" function and involves a further decoding and re-coding of the associated channel.

Consequently, along the programme production and distribution chain, the signal might easily encounter up to five cascaded encodings and decodings and this could lead to severely degraded picture and sound quality. What is required is a solution that enables a signal to be decoded and then

re-encoded without the build-up of compression impairments. The solution developed within the ATLANTIC project is based around the "MOLE" as described in the next section. MOLE-based techniques were first proposed in [3].

3. Introducing the MOLE [2]

3.1. Video

3.1.1. Transparent cascading

It is possible to decode a video signal from MPEG and recompress it back to an almost identical MPEG bitstream (a clone of the first bitstream), provided that the second encoder can be forced to take exactly the same coding decisions as were taken by the first encoder. This is not necessarily an obvious result because the input to the second encoder contains coding noise introduced into the source signal by the first coding and decoding process. A short explanation which illustrates how the transparency of decoding followed by re-coding can be achieved is given in the adjacent text box.

The relevant decisions / parameters used by the first encoder which must be re-used in the second encoder include the following:

- the motion vectors for each macroblock;
- the prediction mode for each macroblock (frame / field, intra / non-intra, forward / backward / bi-directional etc.);
- the DCT type for each macroblock (frame / field);
- the quantization step size for each macroblock;
- quantization weighting matrices.

These parameters are necessarily carried within the syntax of an MPEG bitstream because they are required by a decoder to decode the bitstream. What is required is a method of conveying these parameters along with the *decoded* video.

The method being proposed by the ATLANTIC project is to bury the information invisibly in the video signal itself. The buried information signal is called a "MOLE". A straightforward

2. This term has been protected as a Trade Mark by one of the ATLANTIC partners.

The transparency of video transcoding

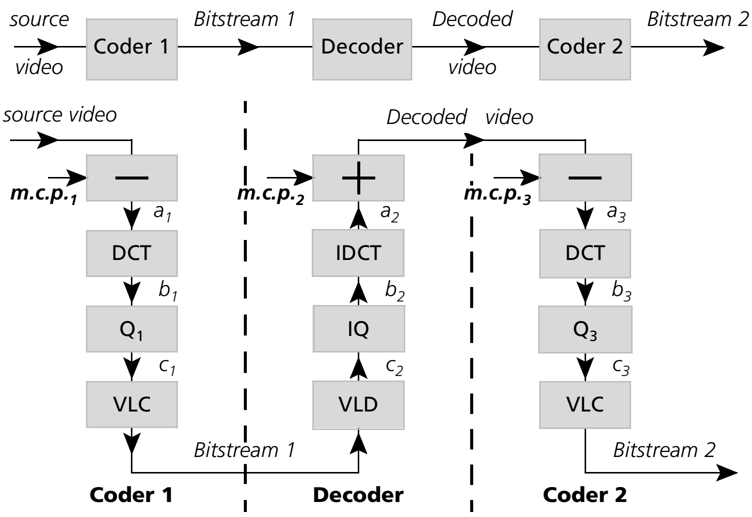

Illustration of transparent coding/decoding/re-coding.

In the figure above, the main processing paths are shown in simplified form for a first MPEG-2 encoder (Coder 1), followed by a decoder and finally followed by a second MPEG-2 coder (Coder 2).

In Coder 1, the difference (a_1) between the source signal and a motion-compensated prediction (mcp_1) is transformed using the discrete cosine transform (DCT). The transform coefficients (b_1) are quantized and coded using a variable-length coder (VLC). The motion-compensated prediction (mcp_1) is formed from previously-coded (and decoded) frames such that the coder and decoder are able to form the same prediction signals.

The decoding process is the inverse of this chain. The variable-length decoder (VLD) undoes the variable-length coding; i.e. $c_2 = c_1$.

At its output, the inverse quantizer (IQ) gives quantized coefficient values (b_2) which are fed to the inverse DCT (IDCT). The output of the IDCT process (a_2) is added to a motion-compensated prediction (mcp_2) to give the decoded output. Since, in a standard MPEG-2 encoder, mcp_1 is constructed to be equal to mcp_2, the decoded output is equal to the source signal with the addition of quantization distortion introduced by the combined process of quantization followed by inverse quantization.

The decoded signal is fed into Coder 2. As in Coder 1, a difference is constructed between the input and a motion-compensated prediction, mcp_3. If this prediction can be made equal to mcp_2; i.e. if $mcp_3 = mcp_2$, then $a_3 = a_2$.

(For an I-frame, the prediction is effectively set to zero and therefore $mcp_3 = mcp_2 = 0$ for this frame. Then it can be shown that the predictions of subsequent frames, mcp_2 and mcp_3, derived from this I-frame will be the same provided that the motion vectors and the prediction decisions are identical.)

Since an IDCT process followed by a DCT process is transparent (one inverts the other), then $b_3 = b_2$.

Since b_3 consists of quantized coefficient values, the quantization process Q_3 will not add any further quantization distortion, provided that $Q_3 = Q_1$. Then the process of inverse quantization (IQ) followed by quantization (Q_3) will be transparent, giving $c_3 = c_2$, and therefore, $c_3 = c_1$.

Therefore, $bitstream_2 = bitstream_1$, provided that the second encoder can match the prediction and coding decisions taken by the first encoder. This is achieved through the MOLE.

method for carrying the MOLE is to use the least significant bit (10th bit) of the chrominance component in the standard digital interface for component video signals (ITU-R Recommendation 601). Three factors which support this format for the MOLE are:

- the data is invisible even on the most critical test material;
- MPEG is basically an "8-bit format" and therefore the two least significant bits of the standard 10-bit interface are not active for a signal that has been decoded from MPEG-2;
- subsequent (8-bit) encoders will not code this chrominance bit.

It should be noted that, in order to be able to generate the MOLE, no additional information has to be added to the bitstream apart from that required to decode the bitstream.

3.1.2. MOLE-based architecture

A basic video switch / mixer architecture using the MOLE is shown in *Fig. 2*. It comprises a standard component digital mixer with inputs coming either from MPEG decoders or from an uncompressed source such as a camera or from some other form of digital decoder such as a JPEG decoder. The MPEG decoders add the MOLE information to their decoded output. When a decoded MPEG input is selected by the mixer then the decoded signal plus the MOLE is carried transparently through the mixer to the following MOLE-assisted encoder. This encoder recognizes that a MOLE is present and locks its own internal decision processes to the parameters carried in the MOLE. Then the output MPEG bitstream will be the same as the selected input MPEG bitstream.

During a switch or cross-fade to another decoded MPEG input on the digital mixer, there will be some frames where the MOLE signal is not valid or has become corrupted. The MOLE signal contains information which enables checking of the validity or corruption of the information carried; if the MOLE is not valid, then the encoder uses its own internally-derived parameters in place of those carried in the MOLE. When the switch or cross-fade has been completed and the second decoded MPEG signal has passed transparently through the mixer, then the MOLE signal will again become valid and the encoder can lock onto the new information. Within a few frames the coder will be producing an MPEG bitstream which is the same as that being fed to the second decoder.

Consequently, such an architecture provides for a seamless transition from one MPEG bitstream to another. This is achieved without imposing any constraints on the type or relative timing of the Group of Pictures (GoP) structures of the input MPEG bitstreams, nor any constraints on the frames at which the transition occurs. Away from the transition there is no loss of quality resulting from the cascaded decoding and re-coding of the MPEG bitstreams. However, during the transition period, the signals are effectively decoded, combined and re-coded with new coding parameters (such as picture type and quantizer step size etc.). Simulations and initial real-time tests of such a switching process have consistently shown that any generational loss of picture quality is not visible during the short period of the transition [4].

Because the switching is done in the decoded domain, this architecture enables MPEG compression to be used without loss in conjunction with conventional systems which use no compression or only mild compression (such as the Digibeta, JPEG, DV or SX formats). When the MPEG source is selected, the signal will be re-coded without loss because of the presence of the MOLE. When a non-MPEG source is selected, the MOLE will cease to be valid and will then disappear. At this point the coder will start to use its own internally-generated decisions to move seamlessly towards coding the new source signal as a stand-alone coder.

A MOLE-based architecture can be used equally well with MPEG-2 video bitstreams which have been coded in a variable bit-rate (VBR) mode, and with bitstreams which have been coded in a constant bit-rate (CBR) mode.

3.1.3. Video MOLE format

A format for the MOLE has been proposed and is currently under discussion for standardization within the EBU / ETSI Joint Technical Committee and the SMPTE [5].

In the proposed format, the MOLE data is both picture- and macroblock-locked; this means that the data which relates to a given 16-pixel by 16-line macroblock is co-sited with these 256 pixels on the 10th bit of the chrominance samples in the macroblock. Of the available 256 bits per macroblock, the majority of these are taken up with data that changes at macroblock rate, e.g. the motion vector data. Information that only changes at the picture rate is distributed across the picture in reserved slots within the macroblock data format. This picture-rate information is repeated five times across the picture in case some parts of the picture are changed during the mixing operations.

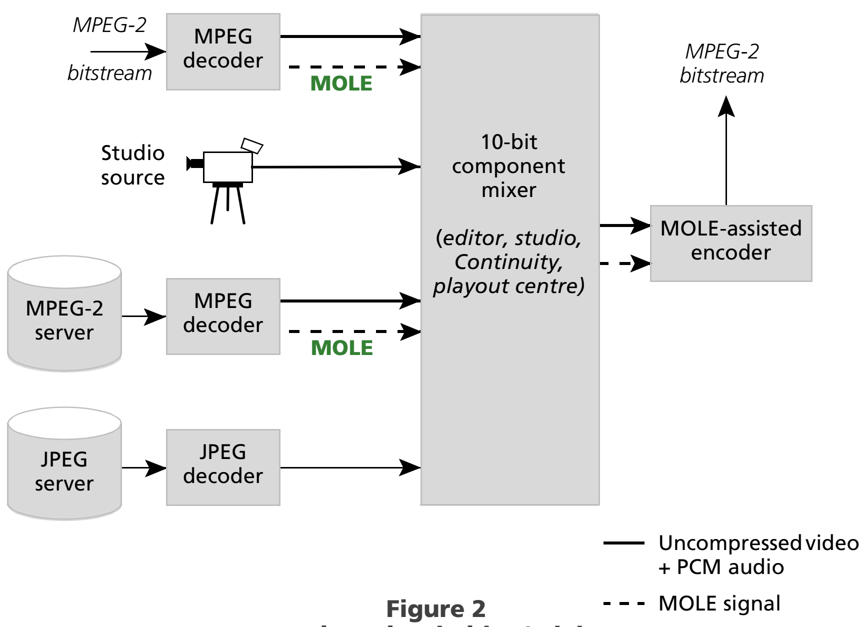

Figure 2
MOLE-based switching/mixing.

Other information carried in the MOLE data includes a rolling macroblock count and a cyclic redundancy check (CRC) across all the data in the macroblock. The macroblock count is not picture-locked and can be used to detect a wipe or switch between two different decoded sequences. The CRC is used to detect whether the MOLE data has been corrupted as a result of any picture processing applied to that macroblock. In order to reduce any possibility of the MOLE data being visible, the data is scrambled using a method known as "signalling in parity". The parity of one chrominance sample (including the MOLE bit) and the following luminance sample is made "odd" to carry a data bit equal to "1" and made "even" to carry a "0" data bit.

3.1.4. Examples of MOLE in use

A particular example of the use of MOLE data is in the insertion of captions or logos into a decoded MPEG sequence. Those macroblocks within a picture which have been changed in any way by the inserted caption or logo can be detected by using the CRC data. The coder can then re-code the affected macroblocks using locally-derived optimum decisions. Those parts of the picture which are not affected by the insertion can be re-coded transparently using the valid MOLE data.

The MOLE should also be applicable in cases where the original MPEG sequence was coded with fewer pixels per (active) line than the number defined for the digital studio standard. For example, some early MPEG implementations for standard-definition TV chose to code only 704 out of the standard 720 pixels/line. Alternatively, the MPEG signal may have been coded at a lower horizontal sampling frequency such as 528 samples/line. In such cases, after decoding to the full studio standard of 720 pixels/line, it should be possible, if required, to re-code back to the same MPEG bitstream with the same number of samples/line and with the macroblocks in the same positions relative to the picture material. Therefore, it is necessary for the MOLE data to include some form of synchronization code which can be used to locate the positions of the original macroblocks in the decoded data. Note that when a lower horizontal sampling frequency has been used, the area corresponding to a coded macroblock in the decoded (and up-sampled) picture has a length greater than 16 pixels. Also, when a lower horizontal sampling frequency has been used, it is necessary for the process of up-sampling followed by down-sampling of the video to be transparent. This can be done by using a carefull combination of up- and down-filters for sample-rate conversion to and from the full sample rate.

3.1.5. Alternative methods for carrying MOLE data

In some cases, it may not be appropriate to carry the MOLE data on the least significant bit of the decoded chrominance component; for example, it may be required to store the decoded MPEG sequence on a video tape recorder which uses a small degree of compression. This compression would be sufficient to corrupt the MOLE data without perhaps adding any visible degradation to the picture material. In this case, the MOLE information can be carried as an ancillary signal. An efficient way to code the MOLE information is then to keep the data in pseudo-MPEG-2 form but to remove all the video coefficient information (which takes up most of the bit-rate in a typical MPEG-2 bitstream).

3.1.6. Chrominance subsampling

The version or type of MPEG-2 coding which will be used primarily for distribution is referred to as "Main Profile". In order to obtain the best overall picture quality at a given bit-rate, this profile uses half the vertical chrominance sampling frequency of the studio standard (e.g. 4:2:0 as opposed to 4:2:2 resolution). Therefore, each coder is required to vertically pre-filter the chrominance component before reducing the sampling rate prior to coding, and each decoder is required to vertically filter the chrominance output as it increases the vertical chrominance sampling rate back to the full rate.

In the cascaded decoding and re-coding process shown in *Fig. 2*, it is possible that the cascaded application of up- and down-conversion filters adds further resolution loss to the chrominance component. However, it is easily possible to make the system transparent to the up- and down-conversion processes by ensuring that the combined response of the decoder and encoder filters is "Nyquist". The presence (or not) of a MOLE can be used to determine whether or not the video signal has undergone any previous filtering and can be used to adapt the coder pre-filter accordingly.

3.2. Audio

The same MOLE ideas can be applied to audio in order to avoid the impairments introduced by succesive decoding and re-coding of compressed audio signals. Such cascading is inevitable in the TV broadcast chain shown in *Fig. 1* but it is also likely to occur in similar audio-only production and distribution chains for digital audio broadcasting.

For transparent decoding and re-coding, the second coding process is required to take the same coding decisions as the initial coder. For audio, the main decisions which need to be kept constant are (i) the positions of the audio block boundaries and (ii) the quantization step sizes for each of the frequency sub-bands within each block. For MPEG Layer-II coding, the block boundaries occur at regular intervals; for example, at 24 ms intervals for 48 kHz sampling. A quantization step size is transmitted in the compressed bitstream as a combination of two parameters, namely a *scale factor* and a *bit-allocation* for the sub-band.

As with the video, the audio MOLE information can be added to the least significant bit of the decoded PCM audio signal; for example the 20th bit in typical digital audio installations. It is proposed [6] to scramble the MOLE data via "signalling in parity" whereby the MOLE data is used to control the parity of each (20-bit) audio PCM sample. A 20th-bit MOLE is completely inaudible and even a 16th-bit MOLE (for 16-bit audio PCM) is only just perceptible on the most critical material under carefully-controlled listening conditions.

Information carried by the audio MOLE for MPEG Layer-II coding includes the following:

- ⇨ block synchronization word;
- ⇨ number of bits of MOLE data per frame;

- an indication of the original sampling frequency;
- mode information (mono, joint stereo etc.);
- copy and copyright flags;
- timing offset information;
- error-checking bytes.

The timing offset information listed above is included primarily for use in TV switching and editing. This field carries information about any "lip-sync" error which may have been introduced during a switch because of the requirement to have both video frame continuity and audio frame continuity in the switched bitstream. Because the audio and video frames have different periods, it will be necessary to advance or delay the audio (by up to 12 ms for Layer-II) in relation to the video after a switching point. The timing offset information can be used to prevent such delays from accumulating along the broadcast chain.

The audio MOLE allows MPEG audio bitstreams to be switched and edited using conventional digital audio studio equipment which may be part of a TV or radio production chain. However, if the audio signal is processed in any way (remote from the switching point) then the MOLE will be corrupted. This means that the gain or frequency equalization of the audio signal should not be altered if transparent transcoding is required. Such a constraint is traditionally more acceptable in TV production than in radio production. If it is required to change the audio signal in some way then transparent cascading is not possible; but quality can be conserved in many circumstances by taking account, in the re-coding, of the MOLE information which would then have to be sent via an auxiliary data path.

4. Changing the bit-rate (transcoding)

There will be a requirement along the TV production and distribution chain to change the bit-rate of the MPEG-2 signal. In particular this will apply to the video component of the signal which occupies the major part of the bit-rate of any single programme. The rate may be changed for example across the playout/continuity mixer shown in *Fig. 2* when the input MPEG bitstream is sourced at a higher bit-rate than that required for distribution.

Within an MPEG encoder, the average bit-rate is determined by the coarseness of the quantization applied to the DCT coefficients. When there is no change in rate on re-coding, then the quantizer in the re-coder does not introduce any further change in the value of the DCT coefficients (see the text box on page 18). However, when the bit-rate is changed, then a second stage of quantization must be applied to the DCT coefficients, thus introducing further noise into the signal. This noise can be minimized by exploiting the knowledge obtained through the MOLE about the quantizer in the previous generation of coding. An optimum quantizer, specifically for transcoding, has been designed within the ATLANTIC project and is referred to as a "MAP" (maximum a-posteriori) quantizer [7][8]. The MAP quantizer specifies how ranges of input levels are mapped onto standard output levels defined in the MPEG standard. This mapping is based on a parametric model of the impairments introduced by the previous generation of quantizer.

Also, by using information carried in the MOLE about the bit-rate statistics of the input bitstream, it is possible to define a good single-pass-rate controller for use within the second-generation encoder [9].

For transcoding, experiments have been done to compare the performance of various quantizers in the second-generation encoder. The results show that the MAP quantizer performs significantly better than a quantizer that has been optimized for stand-alone, single-generation encoding [9]. Also, experiments have shown that, for an optimized two-stage coding (e.g. 5 Mbit/s to 3 Mbit/s), the subjective picture quality at the final bit-rate is no worse than that obtained in going from the source picture to the lower final bit-rate in a single generation, using a coder with a quantizer that is optimized for single-generation encoding.

This is an important result because it means that we are free to change the video bit-rate at critical points in the programme production and distribution chain without suffering any subjective quality penalty in the final decoded output. As a consequence, this allows the use of MPEG compression in archive storage and programme production at bit-rates which are slightly higher than those which might be currently required for distribution. This means that the picture quality/bit-rate of the archived material can be chosen to suit future as well as current requirements.

5. Editing and post-production

5.1. The MOLE and post-production

Using a MOLE-based architecture as shown in *Fig. 2*, it is possible to switch/mix between two MPEG bitstreams with no cascading loss, except for a small imperceptible loss close to the transition. The switching point can be specified to frame accuracy at any point within the GoP structure of the input MPEG bitstreams. Consequently, we have a system which can be used as the basis for editing MPEG bitstreams or for editing between MPEG bit-

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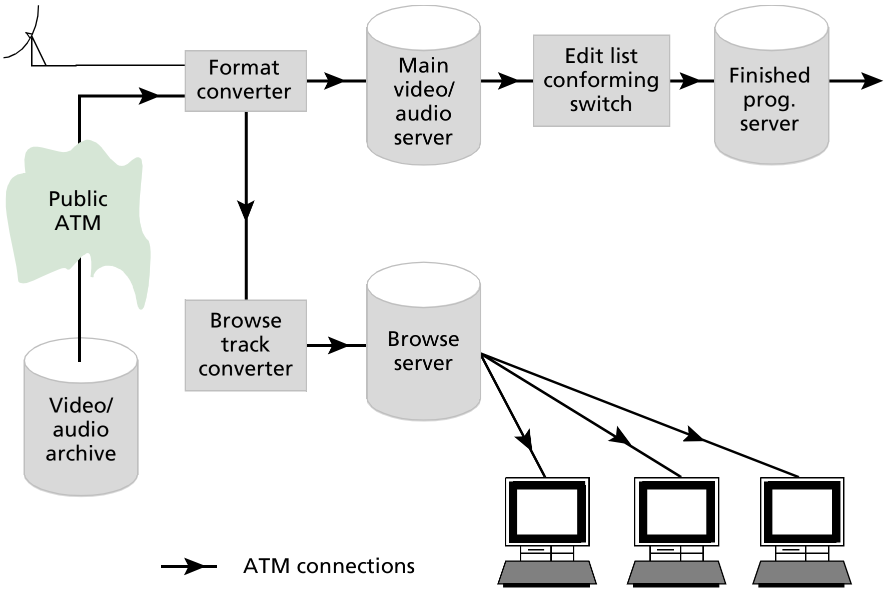

Figure 3
Small studio architecture based around MPEG and ATM networking.

streams and formats that use other forms of compression (or no compression at all).

For the type of programme material that does not involve sophisticated picture manipulation during post-production, the acquisition and post-production could be done using MPEG at the bit-rate which will be used for final distribution. Alternatively, the bit-rate could be maintained at a slightly higher value and transcoded for final distribution. The advantages of using low bit-rate MPEG are:

- low capacity servers;
- low bandwidth servers;
- low bandwidth networking.

For standard-definition TV, a typical bit-rate for an MPEG signal in post-production might be 8 Mbit/s or 1 Mbyte/sec. At such bit-rates it is possible to use conventional IT networks and servers for carrying the programme material. By contrast, other compression schemes being proposed for studio production use bit-rates up to 50 Mbit/s. In such cases, specialized networking solutions dedicated to these high bit-rates are required together with large and specialized servers.

The bit-rates proposed for these other compression schemes are high for two main reasons: (i) because they use little or no motion-compensated processing in order to give frame-accurate editing capability and (ii) to keep the quality high in order to avoid perceptible degradation with multi-generation cascading. However, the problems of frame-accurate editing and multi-generation cascading can be solved by a consistent use of MPEG and the MOLE throughout the production and distribution chain. This solution will be particularly relevant for economic post-production of HDTV because of the significantly higher bit-rates of HDTV signals.

5.2. *Small studio reference architecture*

5.2.1. Functional overview

For post-production, the ATLANTIC project has chosen to develop prototype equipment and applications according to the studio reference architecture shown in *Fig. 3*.

In this architecture, MPEG signals which arrive at the studio are passed through a *format converter* which separates the audio and video components and then packages these in a standard form (as MPEG "PES" packets with one "access unit" or "frame" per PES packet). These standard bitstreams are stored as files on the *main server* together with index files which relate timecode for a given frame to the corresponding byte location within the file of compressed data. The audio and video are separated because there is a requirement in many modern studios for "bi-media" working where radio production and TV production share the same studio and source material. In such studios it would make for inefficient use of network and server bandwidths if both the audio and video information had to be accessed just to get at the audio component.

One disadvantage of the MPEG format in post-production is that it is not a particularly convenient format for browsing through data. This is because the coding algorithm uses inter-frame prediction which results in functions such as reverse play, fast-forward and fast-reverse that are rather limited in performance. Therefore, in the architecture of *Fig. 3*, as the MPEG files are placed on the main server, the signals are transcoded into a second format which is more suitable for browsing and determining the edit points; for example, this could be a browse-quality JPEG format as used in many conventional non-linear editors. In ATLANTIC, the browse format was chosen to be a low-resolution MPEG I-frame only, at a bit-rate of about 4 Mbit/s. The browse data is also accompanied by an index file which relates the timecode of each frame to its byte location within the browse file. The browse data may be stored on a separate *browse server*.

Edit decisions are then taken "off-line" using non-linear editors working with the browse data. The resulting edit decision lists (EDLs) are transferred to an "edit conformer" which is basically a MOLE-based switcher/mixer as shown in *Fig. 2*, but under automatic control. The EDL controls the fetching of data from the appropriate MPEG source files on the main server, making use of the associated index files. The edited programme is stored in its final form on a *finished programme server* ready for use by playout/continuity. As an alternative to a real-time edit conformer, this process could be done by software running in non-real time.

5.2.2. Network infrastructure

In the ATLANTIC studio reference model of *Fig. 3*, all the functional components are connected together via an ATM network. ATM was chosen for its unique characteristics of flexibility, scalability, provision of bandwidth-on-demand and the ability to support a

wide range of quality-of-service requirements (i.e. guaranteed bit-rate) [10].

Within a studio, it is essential to have reliable error-free transmission of data. To meet this requirement it was decided to use the TCP protocol for data transfer since TCP allows for retransmission of any data packets that contain errors. The method chosen for addressing and routeing the data between devices on the network is *Classical IP over ATM*. The performance of such connections has been tested between a range of different platforms and operating systems, and data transfer rates typically in excess of 70 Mbit/s can be maintained over a single ATM connection.

Control of the servers is achieved using protocols which conform to the DSM-CC standard (IS0/IEC-13818-6: Digital Storage Media Command and Control) which is part of the MPEG-2 "family" of standards.

5.2.3. Decoder synchronization

Within the studio environment there is usually a requirement for a decoder to be synchronized to a studio reference signal. Also, for automatic playout control and for real-time conforming of edit lists, precise control is required of the time that a given decoded frame is displayed at the output of a decoder. Within ATLANTIC this control is achieved by re-stamping all the timing control information within the MPEG bitstream as it passes through the interface from the ATM network to the decoder. This requires that the decoder ATM interface is fed with both SMPTE timecode and the appropriate playout control information in the form of VTR controls or "Louth" server control commands.

6. Summary

The ATLANTIC project has developed techniques for switching and editing MPEG bitstreams based on transparent, successive, decoding and re-coding of the compressed bitstreams. The techniques involve the use of a MOLE which conveys information about the original video and audio coder decisions within the respective decoded signals.

MOLE-based architectures allow MPEG to be used in a consistent and conventional way throughout all stages of the programme production and distribution chain. Use of MPEG can offer big savings in server sizes, server bandwidths and network bandwidths compared with the use of other compression formats for which the bit-rate is several times higher. These savings could be particularly important for HDTV systems. Also, MOLE-based architectures allow MPEG to be used without loss alongside other alternative compression formats.

Proposals have been submitted to the EBU/ETSI and the SMPTE for standardization of the MOLE signals.

The ATLANTIC project is developing equipment for demonstrations in 1998 of a complete programme production and distribution chain.

Acknowledgements

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Higher-level teletext in action

D. Kramer
Swiss TXT

"Level 2.5" teletext offers several important advantages over the current teletext standard (known as level 1.5 teletext). Firstly, level 2.5 teletext incorporates several different character types, and proportional spacing between the characters. Secondly, it provides for improved graphics including acronyms and logos. Thirdly, it incorporates a much better colour palette. It also offers potential enhancements when received on a widescreen (16:9) teletext receiver.

The Author describes here his experiences with the introduction of level 2.5 teletext services in Switzerland (up to the end of January 1998), in particular the problems that have resulted from the software and the equipment manufacturers not following the level 2.5 specification very diligently.

Introduction

The current teletext standard – which is described as *level 1.5* – has been around for over twenty years. It can reproduce the text characters of several different European languages – a feature that was included for the benefit of those broadcasters who would want to provide teletext services in up to three different languages, e.g. in Switzerland.

However, level 1.5 teletext has its limitations:

- it utilizes only a single fixed-space character type;
- the graphics are very rudimentary;
- the choice of colours is very restricted.

Level 2.5 teletext screen (Philips) showing a page produced by Swiss TXT on behalf of the satellite channel, 3sat.

Some years ago, at the initiative of a number of TV manufacturers, several broadcasters and the EBU began discussions on the possibility of improving the level 1.5 teletext standard. Agreement was reached in record time. A basic requirement of the broadcasters was that compatibility between level 1.5 teletext and the proposed level 2.5 standard should be assured in both directions. This means that reception of level 2.5 services (at least in respect of their basic content) has to be possible on a level 1.5 receiver, and reception of level 1.5 teletext has to be possible on a level 2.5 receiver.

The level 2.5 teletext standard was submitted in 1995 to EACEM for approval, and then to ETSI for conversion into a European standard [1].

Original language: French
Manuscript received: 31/1/98.

Advantages of level 2.5

Until now, teletext has allowed the use of only a single fixed-space character type. Level 2.5 teletext incorporates not only *several character types*, but also *proportional spacing* between characters. This has been made possible by constructing each teletext character from an array of 12 x 10 points, which not only extends the typographical possibilities but also improves the legibility of the text.

Clearly, this improvement also offers greater possibilities in terms of *teletext graphics*. The reproduction of acronyms and logos – an indispensable feature of commercial text-based services – is no longer restricted to simplified and rudimentary reproductions. This has been made possible by means of *Dynamically Redefinable Characters* (DRCs) which, however, are limited to just 24 characters per page. In addition, the editor can specify *objects* – a combination of graphics, logos and colours – which can be superimposed on a traditional teletext page. These objects cannot of course be reproduced by level 1.5 decoders.

The *colour palette* – previously limited to 32 shades in level 1.5 teletext – has been extended to 4,016 different colours. This improvement also offers enhanced legibility by improving the combinations of background colours and text.

In Europe, modern television screens generally no longer have a width/height (aspect) ratio of 4:3. Many of the sets sold today use the widescreen 16:9 format. The blank *side panels* that occur when 4:3 transmissions are received on a 16:9 TV set are generally unused at present for teletext. With level 2.5 teletext, these side panels could be filled with additional explanatory graphics or text (although level 1.5 teletext receivers would not be capable of reproducing this information).

Clearly then, level 2.5 teletext represents a significant improvement in terms of how the service looks on the viewer's television screen. These improvements would, of course, have been even greater if the broadcasters had not insisted on two-way compatibility between levels 1.5 and 2.5, as this imposed numerous restrictions on the new teletext standard. Consequently, level 2.5 teletext has fewer resources at its disposal than the HTML pages found on the Internet.

The list of enhancements brought about by level 2.5 would be incomplete without including *nexTView*. This is special software – installed in new TV receivers with a level 2.5 decoder – which offers the user a real EPG. Level 1.5 teletext sets will not recognize this information, since it is based on a format they cannot decode.

***NexTView* screen (Sony) showing the on-air service produced by Swiss TXT on the Swiss German-language channel, SF1.**

Abbreviations

DRC	Dynamically redefinable characters
DVB	Digital Video Broadcasting
EACEM	European Association of Consumer Electronics Manufacturers
EPG	Electronic programme guide
ETSI	European Telecommunication Standards Institute
HTML	Hyper-text markup language
VBI	Vertical blanking interval

Production difficulties

As a producer of teletext content, Swiss TXT has had some very difficult experiences with the introduction of level 2.5 teletext. The most serious problems have stemmed from the fact that the production software manufacturers have paid only very superficial attention to the specifications of level 2.5 teletext. In addition, the implementation of new level 2.5 functions in existing software has caused major malfunctions at the page-production level.

After a year of testing, it is unfortunately the case that these problems are still not fully resolved. It has not yet been possible to install some of the functions outlined in the level 2.5 specifications. Furthermore, a teletext service composed entirely of side panels is still not possible. Let us hope that these difficulties will soon be overcome.

At an operating level, it should be noted that the possibility of placing objects or colours in a buffer memory – to be able to reproduce them on other pages – is an undisputed advantage. On the other hand, the restriction imposed on the number of DRCs per page, and also per service, is a serious drawback – particularly for pages and/or services which contain advertisements. Lastly, it became clear in the Swiss TXT production studio that it was indispensable to be able to switch quickly between level 1.5 and 2.5 views of a page, in order to have a better appreciation of the result before sending the page to the transmission server.

Level 2.5 receivers

The same comments unfortunately apply here as in the previous section: receiver manufacturers appear not to have read the level 2.5 specifications very diligently. How else can the fact be explained that, depending on the

equipment manufacturer, the background colours or graphics of a particular page appear with significant differences?

Another worrying matter is that some receivers – which purport to have a level 2.5 decoder – provide only level 1.5 functions in practice. The manufacturer concerned seems to be aware of this matter but continues to use this faulty type of decoder.

Although improvements to teletext graphics have been observed by members of the public, these enhancements are seemingly affected by a fault in certain makes of decoder: when teletext is called up, the receiver initially shows level 1.5 information and only switches to the level 2.5 mode after several seconds, adding firstly colours and then objects.

It was only in December 1997 that Swiss TXT received the first questions from viewers regarding level 2.5 teletext. The reasons are simple. Most manufacturers have until recently been unable to supply receivers fitted with level 2.5 teletext decoders. Also, in many cases, there is no mention of the new functions provided by level 2.5 teletext in the user's instruction booklet. Retailers, for their part, have only a very rudimentary knowledge of level 2.5 teletext, or are completely unaware of it.

It would seem that the manufacturing industry has made no effort to spread the word about level 2.5 teletext!

Support from industry

Here we arrive at the key problem which is affecting the introduction of level 2.5 teletext. For many years, the manufacturing and retailing industries have been complaining of falling sales of TV sets. As is well known, an upturn cannot generally be achieved simply by lowering the prices, but requires the introduction of new features which provide the viewer with significant added value.

Level 2.5 teletext – and also *nexTView* which is very closely associated with it – was a strategy for revival, designed by the industry. One positive point during the level 2.5 standardization process was the good collaboration between the broadcasters and the content providers from a very early stage. Unfortunately this excellent co-operation ceased to exist with the end of standardization. The manufacturing industry then proceeded single-handedly to determine the strategy for introducing and launching level 2.5 teletext in the marketplace.

Today, only a few TV sets on the market have the necessary level 2.5 teletext decoders, and the public has still not been properly informed on this matter. Content providers, for their part, are very sceptical about whether it is worth investing large sums of money in a technology which is in danger of never being introduced.

Broadcasting situation

Level 2.5 teletext is currently being broadcast only by ARTE, ARD / ZDF, Bayern 3 and Swiss TXT. The situation regarding *nexTView* is even less encouraging. Apart from some tests in Belgium, France and Holland – it is only Swiss TXT that is broadcasting it regularly on three of its networks in Switzerland, as well as on behalf of TV5 and Euronews. It is to be hoped that two or three other teletext broadcasters will introduce *nexTView* before too long.

Despite this disappointing situation, the reaction of the public is stronger than expected. Swiss TXT has recently started to receive calls from Switzerland and abroad, asking for a list of other broadcasters who are now providing level 2.5 teletext. Interest in this subject seems to be particularly keen in Germany. This proves indeed that, with better co-ordination and motivation of the teletext providers, and also with better information given to the public regarding this new technology, significant progress could be made with the introduction of level 2.5 teletext services.

Future teletext developments

Our experience with level 2.5 teletext also makes it possible, at least in part, to answer the following question: *where are we going with teletext in an increasingly digital environment?*

As mentioned above, even level 2.5 teletext looks slightly outdated when compared with the HTML protocol used, in particular, on the Internet. An integrated circuit already exists for a computer platform that is capable of carrying an HTML protocol via the television VBI. Such a service has little chance of being developed, however, as there is practically no spare VBI capacity available for it in most existing television services.

The outlook for the development of a level 3.5 teletext – which is two-way compatible with the existing teletext standards (1.5 and 2.5) – looks very bleak indeed: it would probably be rapidly outmoded by the introduction of digitial television and data services.

For digital television the situation is a little different. The DVB standards are now being introduced rapidly for economic reasons, firstly on satellite but also on cable. The TV set itself will not change so quickly: in the immediate future, most viewers will buy an add-on DVB receiver to use in conjunction with their existing TV set. Broadcasters who wish, for one reason or another, to change to a digital television service will try firstly to con-

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tinue with analogue teletext, since current TV sets can only receive this standard. The fully-integrated digital TV set will only become established on the market in the years to come. Priority should therefore be given to ensuring the continuation and development of the existing teletext services!

Lastly, it should be noted that broadcasters and the industry still have one very important task to accomplish. The DVB standards used in Europe for digital television have a data-carrying capacity which has already been standardized. What is lacking, on the other hand, is a comprehensive structure for a data service based on the HTML protocol. The aim of this development is simple: the digital TV set and its remote control unit must be able to manage this data in a clearly defined way. This will require a data decoder which is similar to today's teletext decoder. Only in the United Kingdom – where the introduction of terrestrial digital television is under way – has it been realized that action is urgently needed in this direction.

Let us hope that these UK trials result in a standard – for the transmission of HTML-based text and graphics in parallel with digital TV programmes – that is applicable not just to the UK but to the whole of Europe!

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EBU Official Technical Texts: 1998 edition

The first EBU Technical Standards, Recommendations, Statement and Information documents, known collectively as the *EBU Official Technical Texts*, were issued in 1979. These texts concern every aspect of broadcast engineering and operations, and have as their principal objective the harmonization of technologies and working methods as a means of facilitating broadcast operations at all levels. The number of texts issued since 1979 has steadily increased and over 130 are in force today. The issue of individual texts was recently discontinued but – for the benefit of research establishments etc. – all the current texts are collected together in a single volume which is updated annually.

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Introductory scenarios for interactive television

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This article has been adapted from a report [1] prepared within the European Union's ACTS INTERACT Project [1]. It concerns the choice of options for the introduction strategies for interactive television services. Interactive television has been seen as an exciting addition or even an alternative to traditional "passive" participation by the viewing audience, since it offers the viewer more overt opportunities for responding and contributing to programmes.

Options are considered for the introduction of interactivity into the existing analogue television broadcasting environment, and also for the new digital domain where return-channel technology may be a prerequisite for Conditional Access security and to enable payment for the programmes. The success or otherwise of such new services is seen to depend vitally on the simultaneous co-existence of three factors: Technology, Infrastructure and Content.

The market for interactive services offers much potential in Europe, especially for attracting the younger generation of viewers. However, it is recognized that there is, as yet, no clear "killer application". The particular market drivers and the possible future roll-out of interactive services are considered, against the background of very different national situations among the countries of Europe.

1. The report, on which this article is based, was a collaboration by the Author with colleagues from a number of INTERACT project partners. The contribution of Dr Robert Allan (ERA – UK) on Interaction Channel Technology Options is particularly acknowledged.

1. Introduction

The concept of *interactive television* covers a wide range of services and systems. In itself, it simply means that the viewer is able to provide some personal input or feedback that has an influence in what he / she sees, hears or is subjected to. This feedback may go no further than the internal electronics of the television, or it may be sent back to the service provider or programme provider via an "interaction channel".

The impact of this feedback can range from some means of participation in an activity which is created by the receiver (e.g. a game), via voting in response to the programme being broadcast, to directly selecting the entirety of the programme being viewed.

In addition to understanding that interactivity covers a wide range of systems and services (i.e. the degree of interaction and its possible impact on the programme), it also has to be understood that concepts of interactivity are now often intimately bound up with the concepts of *multimedia*. Multimedia can be taken to mean literally a programme, presentation or recording that is made up of elements of video, audio, graphics, text and any other viewable manifestations. However, in practice, these programme elements (sometimes called *programme objects*) are connected to each other in ways that often have a degree of interactivity, in the sense that the viewer or user is able to control the assemblage of picture elements, or move from one to another by a feedback process. Multimedia in practice is the combination of (i) the use of a number of programme objects and (ii) interactivity.

The issue of media interactivity is also virtually synonymous with the issue of *media convergence*: the gradual overlapping of the technologies used for broadcasting, telecommunications, computers and publishing. It is these forces which are leading the broadcasters towards interactivity, and providing the technical tools to make this possible.

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In order to provide the viewer with an interactive service, a vast range of possibilities can be covered. At the time of writing there is no universal agreement, or indeed, no large body of evidence, about which type of interactivity will represent the best step forward for the media delivery world (moving beyond today's linear broadcasting services).

Some systems and ideas have been tried and tested, others have not. Some are based on extensions of existing services; others are entirely new options for the programme-maker and the viewer. The media delivery world awaits guidance with clear signs of the directions that should best be taken.

2. ACTS INTERACT project

The ACTS INTERACT project has studied one general class of interactive systems and, within that, two particular implementations. The class of systems studied is that where a return channel (or, more generally, an interaction channel) is added to an existing broadcast channel. The two implementations are:

- the use of a UHF over-air path for the return channel, probably via the viewer's existing receiving antenna and a local-area UHF collector receiver;
- the use of a cable channel to provide both the forward and return paths (in another part of the cable frequency band).

Even though this technology is constrained, it would allow a relatively wide range of interactive services to be provided.

Notions of digital broadcasting have evolved since the INTERACT project was started, and will continue to do so. The new model for digital broadcasting is that it will be a container for digital data, rather than a transport mechanism for a specific television or radio programme channel. The data will be combinations of *linear programming* and *multimedia.*

In a sense, European analogue television today has some elements of a similar philosophy, in that it is a combination of linear programming and off-line broadcasting, known as teletext. It could be argued that teletext, as an information service, was the precursor of multimedia. The new multimedia, which will take over the role of teletext in the digital environment, will certainly provide the same kind of information services (such as news, weather and sports information). However, they will be more attractive visually, in that they will allow elaborate arrangements of stills, moving pictures, audio, captions, texts and diagrams. They may look like extensions of today's glossy colour magazines.

The features of multimedia broadcasting in the digital age will not stop there. It will be possible to link elements of the multimedia directly to the broadcast programmes being aired. They will probably be accessible during the programme itself by means of icons. Furthermore, the multimedia is likely to include programming that can perform tasks within the receiver. In computer jargon, they would be described as *executable content*. This executable content will run in real time while the viewer is using the service, and possibly while a linear programme is running.

In looking forward to future digital broadcasting scenarios that include interactivity, we need to take into account the use of broadcasting to deliver executable multimedia.

2.1. *"Greek temple" model*

In our analysis of the introductory strategies to be used for interactive TV, we can use models to understand the critical factors. One recent analysis [2] suggests that a "Greek temple" model applies for the success or failure of new media systems. The model proposes that success is like the roof of a Greek temple, which is held up by three pillars. If any one of the pillars is weak, the roof will fall. Only by having three strong pillars at the same time will the roof hold. The pillars of interactive TV are *technology, infrastructure* and *content.*

The **technology** pillar poses the question: *can the system be made and is the technology available for consumer production?* If the answer is yes, the technology pillar is strong.

The **infrastructure** pillar asks: *is the infrastructure available to deliver the technology? Are the delivery means (i.e. the transmitters, distributions links and receivers) available, or likely to be available, at a cost that matches the perceived added value of the services that will be provided?* If so, the infrastructure pillar is strong. It can be considered to have a series of segments that correspond to the different parts of the value chain from programme production to the user. This layer model for the value chain was also used in the INTERACT requirements analysis [3].

The **content** pillar addresses the question: *do the contents bring significant added value to the consumer in order to justify the cost of the equipment or subscriptions?* In the final analysis, the content pillar is always decisive for new media systems. People do not buy wires and resistors or raw technology; they buy the means to watch the programmes they enjoy or to receive the services they want. Without compelling content, any amount of new technology has no value.

If we use these tools, we should find an insight into whether a new media delivery system is likely to be successful, or not.

One of the startlingly successful interactive media delivery systems is the *World Wide We*b. The run-away success of the Web (Internet) suggests that its three pillars are very strong. Indeed, it clearly has very strong infrastructure and content pillars. There is a vast range of available content on the Web which is largely unavailable elsewhere ("TV with 5 million channels"). The infrastructure is strong because the receiver is the home PC that already exists in large numbers.

Arguably, the technology pillar associated with the Web is not very strong. The technical system of the Internet has been built up over the years and few would regard it as well-engineered in the traditional sense. However, it works, and this is what matters.

Success is less clear for broadband networks or Full Service Networks (FSNs). There have been over a dozen trials throughout the world, with Video-on-Demand (VoD) as the core service. The results of these trials can be seen at best as ambivalent. At the time of writing, no operator of a VoD/FSN trial has announced plans to continue the services beyond the trial period (as reported in the ACTS BIDS project). In most cases, these trials have only been moderately successful. This is usually perceived to be because the available content has only been of modest interest to the viewer, and probably not dramatically better than that available from other outlets such as over-air broadcasts or video tapes. The technology for the VoD systems has often been very good indeed. Its technology pillar is very strong. This has not however made the system a success. There is a lesson here for the introduction of new media technology in general.

If its infrastructure costs are out of balance with the content value, a new system will not succeed or, at best, will have a very slow roll-out.

3. DAVIC model

Another important element to consider is the development in the Digital Audio-Visual Council (DAVIC) project on interactive systems. The DAVIC project has adopted a generalised model of interactive delivery systems that is intended to cover all classes of systems, but was initially intended to meet what was seen as the most pressing need – a model for the delivery of VoD or services-on-demand. The model is thorough and appropriate for this context.

We can note that in the DAVIC project there is disappointment that the DAVIC systems for VoD are not being used in practice. This is not because there are technical defects with the technology proposed. It is rather because there are no concrete plans to introduce VoD services. This may be largely for the reasons given above – a lack of sufficient compelling content.

However, DAVIC has recently turned its attention to the development of specifications for hybrid delivery systems that combine the use of a digital broadcast channel with the Web. It has developed an *Enhanced Digital Broadcasting* (EDB) contour with two variants. The first variant supplies Web-format signals in a one-way digital broadcast channel, alongside a linear programming channel. The second variant couples the digital forward channel to an Internet channel, which provides the interactive capacity for the Web-delivered pages. This can in turn be made to provide feedback for the linear channel if needed.

This EDB contour seems particularly relevant for interactive television, and needs to be considered carefully when formulating the introduction strategies.

4. Analogue television

Starting from the perspective that there is a long-established popular TV service or bouquet of competitive/complementary programme services in every European country, we can examine the ways in which interactivity can be added to the programming. Local interactivity is already well established through the medium of teletext. There is a very large installed base of teletext receivers and the typical viewer makes use of this service for a number of minutes per week.

The bugbear of teletext has always been the long waiting time experienced by the viewer. Although this aspect has been improved over the years by (i) the

Abbreviations

ADSL	Asynchronous digital subscriber line
API	Application programming interface
CATV	Community antenna television
DAM	DECT authentication module
DAVIC	Digital Audio-Visual Council
DECT	Digital enhanced cordless telecommunications
DSP	Data services profiles
DTH	Direct-to-home
DVB	Digital Video Broadcasting
DVB-RC	DVB - Return Channel
EDB	Enhanced digital broadcasting contour
ETSI	European Telecommunication Standards Institute
FSN	Full service network
GSM	Global system for mobile communications
HTML	Hyper-text markup language
IB	In-band
IDB	Interactive digital broadcast contour
IF	Intermediate frequency
ISDN	Integrated services digital network
ISO	International Organization for Standardization
LAN	Local area network
LMDS	Local multipoint distribution system
MPEG	(ISO) Moving Picture Experts Group
OOB	Out-of-band
OSI	Open systems interconnection
PPV	Pay-per-view
PSTN	Public switched telephone network
SFDMA	Synchronous frequency division multiple access
SMATV	Satellite master antenna TV
SMC	Subscriber management centre
STB	Set-top box
TCP/IP	Transmission control protocol / Internet protocol
TDMA	Time-division multiple accessl
URL	Uniform resource locator
VDSL	Very high bit-rate digital subscriber line
VBI	Vertical blanking interval
VoD	Video-on-demand
WRS	Wireless relay system

addition of more memory in the receivers (up to a certain cost limit) and (ii) by the use of more transmission capacity (up to the maximum that the vertical blanking interval (VBI) of PAL and SECAM signals can support), there still remains the question of how to manage the memory intelligently in order to anticipate the use that will be made by the viewer. The teletext page must already be stored in the receiver before the viewer selects it.

Ultimately, there remains the problem of channel-changing which requires a fresh start in storing the contents of the teletext magazine. Although teletext has been in use for over twenty years, developments continue (see the article starting on *Page 24* [4]). Teletext is a well-understood model for the management of any interactive data broadcast that uses the "carousel" approach.

In order to provide full interactivity, a return channel must be provided. The fundamental problem that must be overcome is the traditional cycle of "the chicken and egg", applied to the investments made by broadcasters and consumer manufacturers. For the broadcaster, a new service will only justify important investments in programme content when the potential audience that is equipped to receive and use the service is large, i.e. there are many receivers in the field. Equally, for the manufacturer, the market for consumer products will only justify large-scale production runs and achieve the economies of scale needed for consumer products to be competitively priced, if the services offered by broadcasters are sufficiently attractive to the viewers.

The initial start-up phase is therefore difficult. The traditional approach has often been for the broadcaster to start a new type of service that can only be received by a very small audience equipped with expensive prototype receivers. Only then may the consumer manufacturers gear up for mass production, a process which usually accounts for a delay of 18 to 24 months. Hence the broadcaster may need to justify operating a new service with a near-zero audience for up to two years. A faster start-up may require the purchase by broadcasters of large numbers of first-generation products, or subsidies from the broadcaster to encourage the purchase of products which in the early days may seem too expensive to the public.

In the case of analogue television services, the added value of interactive services – as perceived by the viewer – must equate to, and justify, the added cost brought about by the inevitable subscription fee and the purchase or rental of the necessary set-top box (STB).

Two models of possible full interactive services are emerging, based on two different approaches to the interactive experience. In the first model, the viewing public is seated in the comfort of their sofas and armchairs, watching the programming on a TV set but interacting with it via hand-held control units (possibly several). An example of this would be represented by *Two Way TV* ™ [5].

In the second model, a lone viewer is seated at a PC, watching TV in a "window" which occupies perhaps a quarter of the monitor screen. Other windows on the screen provide tools for navigation, such as directory trees, while others contain information related to the TV programming. One such example of this would be the *Intercast* ™ system [6].

Two Way TV ™ model

This model adds formal interactivity through the use of electronic equipment to what was an informally interactive situation – the "family viewing experience". *Two Way TV* ™ has identified that an attractive feature of games shows is the competition which takes place within the small audience in one home, against each other and against the benchmark set by the contestants on the TV programme. The *Two Way TV* ™ technology formalises the game between viewers by allowing them to record their performances (speed of response, number of correct answers) in the set-top unit, and subsequently to compare their performances with the studio competitors and ultimately with all other interactively-equipped players.

The list of programmes originally used for the trials consisted of mainly quiz / games shows, soap operas and sports events. It was offered to 200 homes without payment and subsequently was offered to subscribers who also had to rent or purchase an STB, The presentation of the added interactive material was carefully arranged to match the programme material so that, for instance, an overlay of text giving an update on the "story so far" would not obscure the action at that moment.

Intercast ™ model

The *Intercast* ™ development is closer to a PC style of usage than that of a TV set. The presentation could be viewed on a TV, but the method of use comes from the experience of the Internet and "Windows", extended to link with broadcast TV. This imposes a somewhat reduced role on the TV programme which is displayed in one window on the screen (as a "picture within a picture"). The moving TV image is surrounded by areas that provide features in common use on a PC. Hence there is a File Manager / Directory Explorer by which the further features of the programme-related addons can be selected and displayed.

Local interaction can be provided where the broadcast data can be accessed at will by the user, and full interactivity with hot-links to Internet URLs by modem and Internet connection.

4.1. Return channel technology options

Clearly, the cable medium offers a natural bi-directional signalling capability, and networks which have been constructed fairly recently may be capable of handling return path traffic. In general however the most widely available option for the return path for analogue television services is the telephone modem link. The penetration of telephone lines into the homes of the viewing public makes the possibility of attachment universal. This does not imply that there are no difficulties in doing so, and it may be that it is often inconvenient to make the physical connection between the STB and the telephone line. The point of entry of the antenna and cable feeds is often not close to the telephone termination point.

4.2. Interaction channel protocol options

Using the telephone network for the return / interaction channel, two options of connection are possible. In the first, a call is established to the Interactive Service Operator; in the second, the call is made to an Internet Service Provider after which the inter-

action messages are passed between the Interactive Service Operator and the user via the normal Internet protocols. Both connection types may take advantage of local telephone call charges by the use of special numbers and by automating the call-routeing.

For the present, set-top boxes, such as those used for *Two Way TV* ™, dial directly to the service operator using an interaction protocol of proprietary design. This has the primary advantage of being under close control and relatively rapid for call set-up and close-down. Where there is already synergy with the Internet, such as in the *Intercast* ™ service, the Internet protocols of TCP/IP and World Wide Web data structures such as HTML are a natural choice. The *Intercast* ™ system uses TCP/IP adapted for one-way delivery via the television VBI, and HTML data structures for the Web-style additional material which accompanies the TV programme.

For the majority of interactive services, where telephone call times have to be kept to a minimum (for many reasons including call charges, other phone users, rapid response, automatic recovery from network congestion), the preference would be to make direct connections to the Interactive Service Operator via a local-call-charge automatic router if available.

4.3. Types of programming possible

The novelty of interactive TV has made some people set out to seek the "killer application" which would establish a mass-market need. The ensuing income from such services would make it economically viable to install the return-channel infrastructure and to invest in additions to the programming content. A large number of trials have embarked on identifying such an application but without any common result. It has often been found that particular features of programming attract significant numbers of users in each trial, but when aggregated these become a collection of highly individual market niches which could only be fully exploited by developing the services and content in depth and breadth.

The populations who have been exposed to interactive trials have usually shown significantly higher interest in the interactive programming than in the passive version of such programmes, or in the other content offered.

Most trials have provided a similar offer of services including additions to games shows, sports programmes (multi-camera angles and updates to the results statistics), current affairs (voting/polling), home shopping, home banking, advertising-linked promotion responses, and educational programmes.

The experience of the many trials has led to some caution amongst potential service providers, with the concept gaining ground that there will be no instant and massive popular demand (the killer application) but that the growth of interest will be slow but steady, and only ultimately will justify the investment. If the introduction of interactive services is seen as a long-haul operation, then a major part of the process will be educating the public to become interested in them and getting them to use the interaction capabilities. There may be more stages of transition from the wholly-passive viewing experience to the fully-interactive experience. In particular, we may anticipate that local interaction may remain an important feature of the development of interactive broadcasting. This would apply especially where true broadcasting to mass audiences of millions of viewers could precipitate an active response which could be overwhelming.

4.4. Different national environments

The continent of Europe provides very diverse examples of broadcasting infrastructures. Consequently, there is considerable diversity in the possible scenarios for the introduction of interactivity.

Some countries have almost no cable distribution infrastructure, while others are virtually 100% cabled. Some countries have only just installed their second national terrestrial analogue programme service, which was provided for in the frequency plan laid down in Stockholm in 1961. Others have many more programme services than originally planned, the limiting condition often being the interference from non-authorized transmissions.

The reasons for such differences are complex with some obvious influences such as the terrain geography, and less obvious ones such as history, commercial economics and political deregulation. Within the limited resources of the INTERACT project, the differences in national environments have been noted.

5. Digital television

Digital television broadcasting is a very new business. A number of programme services via satellite were launched in 1996. The operators of these pioneering services have found it sufficiently important or necessary for business reasons to manage the whole of the delivery chain — from programme provision to STB manufacture. Several examples of what are known as "vertical operations" are now in place, and it can be instructive to look at the differences in what may be considered the relative success achieved by these in the short-term.

Most digital services were launched with interactive features from the very beginning. The technology required by the consumer represents a major investment by the service providers, who have specified in total detail the features of the STB, and negotiated with one or more manufacturers to make large quantities of such boxes. The specification of the STBs, even in the first phase of manufacture (expensive), has had to offer features that are sufficient to provide for its service lifetime which, for consumer equipment, may be 5 - 7 years. The commercial business plan of the new digital services has been largely focused on the attraction to the public of "premium" movies and sport for which a subscription is charged, often with pay-per-view (PPV) supplements.

Where PPV is a critical element, direct interaction between the STB and the subscriber management centre (SMC) is important, and set-top boxes have been furnished with modem facilities. Thus the driver for building an interactive infrastructure has been the need to charge the user payments for his/her TV programme viewing. Once provided, the return channel/interaction channel infrastructure offers distinct security benefits to the conditional access (CA) system which can interrogate the STB smartcard. It may be made further available for other debit

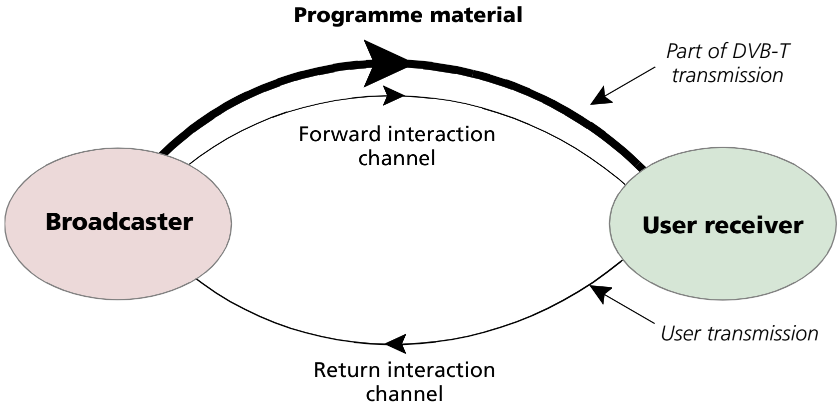

Figure 1
Interactive television system.

transfers, such as for home shopping, or for using Bank Cards which from 1999 will be standardized in Europe.

The digital broadcasting era demands investment in new receiving equipment, whether subsidised and rented to the viewer, or cross-subsidised by the "vertical" service operators (by bringing the retail price down to make an attractive offer to the customer). In either case, the extra cost of including a simple modem in the STB is small. However, as mentioned earlier, it may not be very convenient for the viewer to make the necessary connection to the telephone service, particularly if the socket is in a different room.

For delivery media other than satellite, there has been a different route to developing the services and receiver products. Cable operators have already made very high investments in their analogue technology infrastructure. Some of the older systems are very limited in their capacity, and there are pressures to "go digital" in order to relieve the bottleneck this presents.

In some countries, this overcrowding is seen as an opportunity to overlay the analogue infrastructure with digital terrestrial networks, in order to provide a significant and rapid increase in the transmission capacity. As cable operators often work within restricted environments (franchised or licensed), many of them have formed associations to bring about economies of scale in the manufacture of cable STBs. These associations have developed common STB specifications which have been issued to the prospective equipment manufacturers.

Typical of these, the *Eurobox* from the European Cable Communications Association will make use of the cable connection for interactivity (and will operate alongside other applications such as telephony).

The digital terrestrial market, which will use the DVB-T standard, is now building up to launch in several countries. The terrestrial broadcasting market is the most long-established and, in many countries, has had the express aim of approaching 100% coverage of the population. Until now this market, which is almost entirely free-to-air, has operated "horizontally" where manufacturers are free to offer to the public a range of products for direct purchase to enable them to watch whatever programming they are able to receive. Broadcasters in this market are normally subject to rigorous regulation, and the manufacturer who offers an incompatible or sub-standard product is soon "punished" by the consumer market.

Since the introduction of digital terrestrial transmissions could threaten to interfere with the existing established services, the national regulators are closely involved in the service introduction plans.

In general terms, the introduction of digital broadcasting necessitates the sale or rental of STBs which are, at least initially, relatively expensive pieces of technology. In the consumer market, the first implemented products may need to be amortised over a 5-7 year period. During this time they must continue to function and, if possible, should be able to accommodate the new services and added-value features, the precise details of which are not fully defined in advance. Set-top boxes have therefore been developed to include flexibility, by permitting the future upgrading of the software (e.g. the operating system, the API, the EPG, or even the "look and feel" of the user interface).

Such upgrading may be carried out by a number of different methods but the ability to interrogate the STB via an interactive path offers the prospect of efficient upgrade management and control.

Hence there is little argument for omitting interactive features from digital STBs, especially since the cost of providing a simple modem is very small in comparison with the remainder of the technology.

5.1. Interaction channel technology options

Interactive television requires the addition of both a forward and a return channel, as illustrated in *Fig. 1*. In particular, a new mechanism is required to transfer the data back to the broadcaster (the return interaction channel).

5.1.1. Forward channel

In digital television, the forward channel information can be multiplexed as part of the DVB broadcast transmission, possibly as a "private" data service. The bit-rate associated with the forward channel is controlled by the service provider, and hence its capacity may vary depending on the type of programme material.

A shopping channel, for example, may choose to allocate a high bit-rate to the forward channel and a relatively low bit-rate to the actual programme material (the broadcast video). It will concentrate its limited overall resources on meeting the specific requests of the users (e.g. the specification of items, or information about ordering products), rather than on general programming content.

At the other extreme of interactivity, a programme channel which includes opinion polling may require only a very low bit-rate forward channel, for transferring the questions to the user.

Method	ETSI Standrd	User Usage costs	User equipment costs	Broadcaster infrastructure costs	Required technical development
PSTN	Yes	High[1]	Very low	Low	Little[2]
Cable	Yes[3]	Service-defined	Medium	Low	Some
UHF terrestrial	Preliminary draft within DVB	Service-defined	High	High	High
DECT	Yes[4]	High	Medium	High[5]	Medium
SMATV	Yes[6]	Service-defined	Very high	Low[7]	Medium

1) Currently a call must be created for each user response and as this uses a standard telephone line, this can be an important cost feature. Future systems may be based on a pay-per-usage basis.
2) It can also take full advantage of any improvements in general Internet access technologies.
3) Submitted for final voting proposal.
4) Other alternatives are under discussion within INTERACT and elsewhere.
5) It is possible that an existing infrastructure exists for general telecommunications.
6) Various alternatives have been suggested, some of which are still being discussed in the DVB Project.
7) Could possibly be high if assistance is offered in order to reduce the user equipment costs.

Table 1
Return-channel technologies.

5.1.2. Return channel

The return channel is more complex than the forward channel, as additional features must be added to both the users' and the broadcasters' equipment. It is unlikely that a single optimum solution will ever be created. The various alternatives must therefore consider:

- the usage costs;
- the equipment costs (for the user);
- the broadcasting infrastructure.

A number of return channel alternatives have been proposed and these are summarized in *Table 1*. Wherever possible, use of the existing infrastructure is beneficial. However with either terrestrial or satellite television, there could be an operational benefit in maintaining the return channel under the total control of the system operator and not by using third-party services (e.g. PSTN). There may be disadvantages in areas of high user density, where local distribution points may be needed, thus increasing the infrastructure requirements.

a) PSTN

The simplest solution for a return channel is to use a modem over a standard telephone line, and this approach is adopted on current systems. Due to the low infrastructure costs, both at the user and the broadcaster ends, it is suitable for small pilot operations and can easily be scaled up to larger operations as the user-base increases.

The maximum return channel capacity via a V-series individual modem connection is restricted to 56 kbit/s, with no sharing of facilities being necessary. This is likely to be sufficient for virtually all currently-envisaged interactive applications.

User	Broadcaster
Telephone line	Modem bank
Modem	Telephone line capacity

Table 2
Equipment for PSTN.

Advantages	Disadvantages
Simple user equipment	User call charges
Minimal broadcaster equipment	Revenue gained by telecom operators and not service providers, unless using premium lines
Usable with all forward channels	Telephone line tied up
Relatively large return channel bandwidth	Must be close to telephone access point – reduces portability

Table 3
Relative advantages and disadvantages of PSTN.

The equipment required for a PSTN return channel is given in *Table 2*, and the relative advantages and disadvantages are shown in *Table 3*.

An ETSI standard is available for a return channel over PSTN [7].

A number of trials are also being made with new "xDSL" technologies (ADSL, VDSL etc.) to increase the capacity with higher potential bit-rates, or to provide mechanisms which do not tie up the standard telephone service.

b) Cable

A cable return channel is the obvious solution for an interaction channel in those areas with a cable connection. It offers relatively large bandwidth and does not affect other services. Increased forward-channel capacity is also possible by devoting a spare frequency channel for this purpose.

An ETSI standard has been prepared for a return channel over cable [8][9]. However for Community Antenna Television (CATV), there is also a rival US standard [10] and, since in the UK most cable operators are subsidiaries of US companies, there is pressure to adopt this standard in the UK in preference to the European standard. A review article of the various cable alternatives is given in [11].

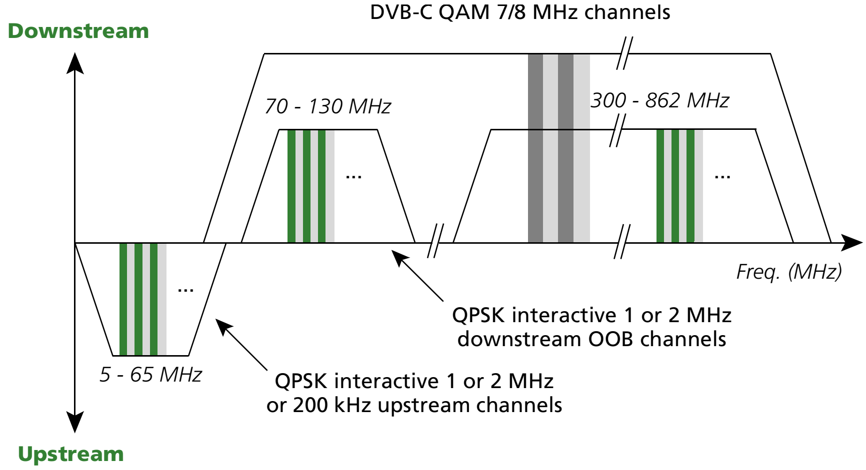

Figure 2
DVB-preferred frequency ranges for CATV interactive systems.

Fig. 2 indicates a possible spectrum allocation for CATV. Although not mandatory, a guideline is provided to use the following preferred frequency ranges:

- 70 - 130 MHz and / or 300 - 862 MHz for the forward channel (downstream OOB);
- 5 - 65 MHz for the return channel (upstream), or parts thereof.

To avoid filtering problems in the bi-directional video amplifiers and in the STBs, the upper limit (65 MHz) for the upstream flow shall not be used together with the lower limit (70 MHz) for the downstream flow in the same system.

User	Broadcaster
Cable user	Receiver for additional frequency channel
Cable modem	

Table 4
Equipment for Cable.

Advantages	Disadvantages
Relatively simple user equipment	User must have cable access
Minimal broadcaster equipment	
Large return channel bandwidth	

Table 5
Relative advantages and disadvantages of Cable.

The user equipment necessary for cable is fairly minimal and may already largely be available to cable users in order to provide wideband Internet access.

The cable specification permits up to 3.088 Mbit / s in the return channel which is shared amongst all users.

The equipment required for a CATV return channel is given in *Table 4*, and the relative advantages and disadvantages are shown in *Table 5*.

c) LMDS

The Local Multipoint Distribution System (LMDS) specification [9] is very similar to the Cable specification. However, in this case the final delivery is via a short-range microwave link in which the forward channel can use an IF within the 950 to 2150 MHz frequency band. The system is aimed at providing a high-speed local distribution from a general distribution network without direct cabling to each terminal.

For the return channels, two different choices can be identified:

- *Out-of-band (OOB) signalling.* In order to maintain compatibility with current equipment which accords with the ETS 300 800 specification [8], 70 - 130 MHz can be used for the forward channel and 5 - 65 MHz for the return channel.
- *In-band (IB) signalling.* Taking into account backward compatibility with the current cable specifications, and in order to give major capacity for future interactive and multimedia services, the frequency allocation is 5 - 305 MHz.

This is summarized in *Fig. 3*.

The LMDS forward channel provides 3.088 Mbit / s for the OOB signals and multiples of 8 kbit / s for the IB signals. It is expected that up to 1000 users of the return channel can be supported.

The equipment required for an LMDS return channel is given in *Table 6*, and the relative advantages and disadvantages are shown in *Table 7*.

d) UHF terrestrial

There could be advantages for terrestrial broadcasters if the whole interactive system were kept within their own

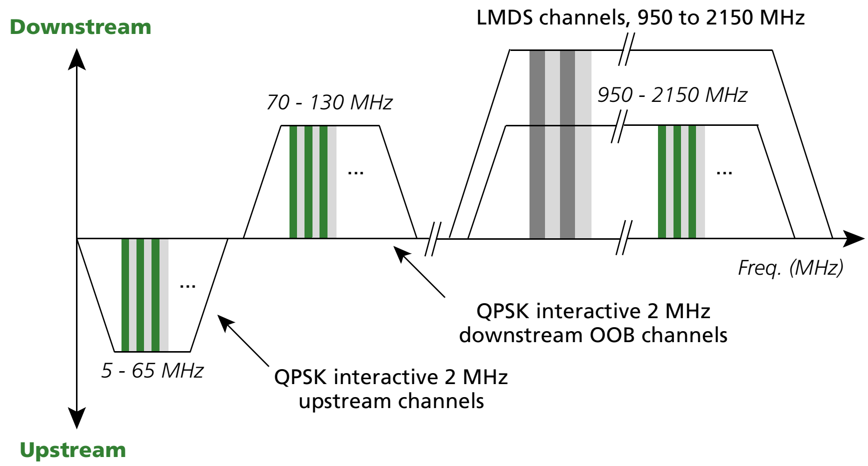

Figure 3
DVB-preferred IF ranges for LMDS interactive systems (OOB).

User	Broadcaster
High-frequancy microwave link equipment	Local distribution points
Cable modem	Receiver for additional frequency channel

Table 6
Equipment for LMDS.

Advantages	Disadvantages
No cabling required from local network to individual houses	Provision of microwave link and associated cabling
Large return channel bandwidth	Line-of-sight operation

Table 7
Relative advantages and disadvantages of LMDS.

domain. Thus a return channel transmitted within the UHF frequency band that is allocated to broadcasting would appear to be very beneficial. However, there is a problem with this approach. While the provision of UHF television services is independent of the user density, the provision of a UHF return channel *is* dependent on the user density: a UHF return channel can work very effectively in rural areas (where the user density is low) but can be very restricted in urban areas (where the user density is high).

A solution to this problem has been proposed by INTERACT [12], based on a cellular infrastructure. By enabling four alternative operating modes, the SFDMA modulation scheme enables a scalable architecture in which additional cells can be added as the user base increases, without affecting any existing users. The roll-out of such a system could therefore be highly incremental, with initial large cells (up to 75 km) being gradually replaced with smaller cells (down to 1.15 km). Since only a 1 MHz slot is required for each cellular station, the facility for frequency re-use is possible – with only neighbouring cells being restricted to different frequencies. The total bandwidth required for the system is therefore minimal.

Spectrum availability is limited and hence the return-channel bandwidth must be shared amongst all users. Whilst it is sufficient for many of the applications that are foreseen for interactive television (e.g. tele-voting, teleshopping etc), it does not compare to that available from PSTN or cable.

The user equipment is relatively complex with a requirement for a low-power UHF transmitter. However with no connections required to other services, the receiver can be readily moved around the home as required. .

The equipment required for a UHF return channel is given in *Table 8*, and the relative advantages and disadvantages are shown in *Table 9*.

The UHF approach offers an expandable solution within the constraints of the existing UHF broadcast band. Whilst the economics are dependent on the number of users, the UHF approach is ideally suited to areas with few users and poor infrastructure (i.e. where a single reception site is sufficient), for example in third-world countries for educational programmes, and for transportability of equipment (e.g. loaning of equipment for market surveys)

User	Broadcaster
Set-top box including UHF modulator and transmitter	Cell reception infrastructure

Table 8
Equipment for UHF terrestrial.

Advantages	Disadvantages
Keeps all of system within control of UHF broadcaster	User equipment cost
Mobility of equipment (i.e. no outside connection is required)	Broadcaster infrastructure
Easy user set-up	Limited return channel bandwidth
	System interference
	Available UHF spectrum allocation

Table 9
Relative advantages and disadvantages of UHF terrestrial.

There are still some outstanding interference issues to be resolved, in that each user transmission could interfere with the neighbouring reception of TV channels. This is currently being studied within the INTERACT project. A very high rejection ratio is required for transmission of the return channels that are adjacent to existing television channels; placement of the return channel at one end of the available UHF band is probably required (which would have to wait for the next formal reallocation of radio frequencies). A separate band could however cause problems when the user transmission is returned via the existing receiving antenna, as it may be bandwidth limited. The receiving antennas that are already in use have often been in place for many years, and it may not be wise to rely on the re-use of this infrastructure "resource".

e) *Digital Enhanced Cordless Telecommunications (DECT)*

In areas of high population density (such as apartment blocks), a cellular system requires microcells and hence the infrastructure is very expensive. A relatively cheap alternative which offers microcells is the DECT system. Operating in the frequency band 1880 to 1900 MHz, it acts as an access network and can distribute the data via other networks (ISDN, PSTN, GSM etc.). However at these frequencies, communication is severely attenuated by walls and other solid objects and, hence, near-line-of-sight operation is necessary.

DECT has features that could be suitable in an interactive DVB system [13] in which the final delivery from the DECT receiver to the broadcaster uses standard PSTN or ISDN facilities. DECT can handle a lot of users in a small area (urban and suburban situation) and can support a broad range of services. A Wireless Relay Station (WRS) can be used to extend the coverage. There is no need for traditional frequency planning as DECT uses dynamic channel selection.

The maximum communication range is limited and hence the number of microcells required is very large. It is therefore unsuitable for rural areas.

User	Broadcaster
Set-top box including DECT equipment	Infrastructure for microcells (may already be present for telecommunications)

Table 10
Equipment for DECT.

Advantages	Disadvantages
Resonable return channel bandwidth	Small cell sizes requiring a large infrastructure
Mobility of set-top box	Unsuitable for long distances
	Near-line-of-sight operation

Table 11
Relative advantages and disadvantages of DECT.

Since the latter is well served by the UHF terrestrial approach, it could be that these two technical solutions could be seen as complementary. However, broadcasters or users may not be able to afford to implement both technologies.

The net bit-rates for standard DECT are:

- 8 kbit / s B-field (traffic) per half slot (unprotected mode);
- 6.4 kbit / s B-field (traffic) per half slot (protected mode);
- 32 kbit / s B-field (traffic) per full slot (unprotected mode);
- 25.6 kbit / s B-field (traffic) per full slot (protected mode);
- 80 kbit / s B-field (traffic) per double slot (unprotected mode);
- 64 kbit / s B-field (traffic) per double slot (protected mode);
- 6.4 kbit / s A-field (control / signalling) per half slot, full slot and double slot.

The DECT standard includes data services. The services and relationships of the different profiles are described in [14]. The data services profiles (DSPs) are a family of profiles which build upon and extend each other, aimed at the general connection of terminals that support non-voice services to a fixed infrastructure, private and public. The application determines which profile type to use, due to parameters such as data rate, latency, reliability and power consumption. They all exploit the powerful lower-layer data services of DECT, which are specifically oriented towards LAN, multimedia and serial data capability. Each member of the profile family has been optimized for a different kind of user service.

DECT has algorithms for authentication of both the base station and the terminal, as well as a simple encryption scheme: DAM (DECT authentication module) card support.

The equipment required for a standard DECT return channel at approximately 1900 MHz is given in *Table 10*, and the relative advantages and disadvantages are shown in *Table 11*.

The technology is currently being studied within INTERACT. Its suitability for the implementation of interactive services has been considered, and different modifications have been proposed in order to improve its efficiency and to make it more suitable for interaction purposes. Amongst these, changes in the modulation scheme, the channel equalization and the implementation of an efficient packet access mode (True Packet Mode) are under study.

f) Satellite

The increase of DTH satellite transmissions indicates the requirement for a satellite interactive system. The ideal system would therefore transmit directly back from the user to the satellite, similar to the proposed terrestrial system.

However, whilst satellite receivers have reduced considerably in cost, a similar reduction in transmission equipment has not been seen. It is therefore unlikely that direct transmission to satellite will be cost-effective in the foreseeable future[1].

A system similar to SMATV reception is therefore envisaged in which multiple users are connected to a satellite distribution point, and solutions via a low rate TDMA coax section [15] or a DECT coax section are being studied [13][16]. The user STB must therefore be capable of this local transmission and various alternatives are possible.

1. The next generation of satellites will permit mobile communication via satellites. However the call charges and equipment costs would indicate that this is still unlikely to be viable for a standard user interactive facility.

Another alternative is a direct user link to the satellite as either Ka / Ku, Ku / Ku or Ka / Ka frequency band solutions, and this is currently being investigated by DVB-RC. However, at the present time, individual user transmitters are prohibitively expensive.

The advantage of satellites is that there is a relatively large bandwidth which could be utilized. However cost factors indicate that probably only a limited bandwidth will be available in practice.

The equipment required for a satellite return channel is given in *Table 12*, and the relative advantages and disadvantages are shown in *Table 13*.

g) GSM

A solution using GSM has also been proposed [17]. However this has still to be passed to DVB-RC for initial

User	Broadcaster
VSAT transmitter (probably shared)	Additional satellite channel
Access to above	

Table 12
Equipment for Satellite.

Advantages	Disadvantages
Wide area coverage	Local infrastructure required to link to VSAT equipment
Minimal broadcaster equipment	Expensive user equipment (if personal VSAT terminal)
Return channel capacity is variable	High user charges
Keeps service within control of satellite operator	
User satellite facilities could be used for other services	

Table 13
Relative advantages and disadvantages of Satellite.

approval. A possible solution is being proposed by the ACTS MEMO project.

5.1.3. Which technology option?

There is probably no single technical solution which can provide the optimum return channel for all users throughout Europe. Broadcasters and manufacturers of consumer receivers must therefore acknowledge this and should design their applications and equipment to be suitably modular in order to support the various alternatives.

The system operators would ideally wish to maintain complete control of the interactive system within their domain. Hence, terrestrial broadcasters would prefer a terrestrial network, and satellite operators a satellite network. However, there remain several technical and infrastructure issues to be overcome.

At present, the telephone network is used for the interaction channel in operational systems, and further developments will lessen the various inherent disadvantages that were described above. To the broadcaster, it offers the advantage of limited infrastructure cost (and this is readily scalable as the number of users increases). To the user, it offers a relatively cheap entry cost at the expense of usage charges.

Hence, apart from cable networks which also offer a readily-available return channel medium, it is expected that the telephone network will continue to occupy the major proportion of future interactive system development.

5.2. Interaction channel protocol options

The DVB project uses an open system interconnection (OSI) layer model to define the interaction protocol generic system reference. This has helped to maintain consistency and to keep as many features in common as possible (e.g. the protocol stacks across the various distribution and interaction media).

A simplified system reference model is shown in *Fig. 4*.

The DVB project began elaboration of commercial requirements and the development of technical specifications for interactive services some years after it began its study programme. Some features of the earliest implementations of interactive services do not necessarily comply with the more recently established DVB-preferred approach. This is unlikely to have important consequences since these pioneering applications are those of the "vertical market" where interoperability is not normally essential. If this situation changes over time, interoperability could be achieved by means of duplicated services.

The operation of various protocols for interaction will more and more become the subject for standardization or, at a minimum, for agreement between associations of service providers. Where the set-top box is not a proprietary unit but is an open standard platform, it will be important that any service operator should be able to address the functions and make use of features such as the interaction channel in a consistent and standardized way. Access from a common API to the hardware and software facilities of the unit will need to be standardized to permit the user to choose services from the widest possible range of providers over any delivery and interaction media.

5.3. Types of programming possible

The range of interactive services which are available now, and which will become possible in future with digital broadcasting, is limited only by the creativity of the service providers and the capability of the STBs and other consumer products. At any point in time there is an optimum processing and memory "footprint" which can be included in the receiver, without grossly distorting the cost of ownership by the consumer (whether the retail price or the monthly rental cost).

Once this footprint has been defined for a particular service, it will become effectively frozen and all interactive services will then be constrained to operate on this "legacy" platform until they can finally be replaced, possibly 5 - 7 years later. The users' perception of the speed and power of the available interactive services will then depend on the bitstream capacity chosen by the service provider for data delivery to the platform, and on the efficiency of

Application layer	*Proprietary protocols*
Transport layer	*Network-independent protocols*
Network layer	*Network-dependent protocols (access mechanisms, packet structures etc.*
Physical layer	*Medium-specific features (modulation, channel coding, frequency, filtering etc.*

Figure 4
Simplified system reference layer model.

the interaction paths, instead of being restricted by the processing power and memory storage capacity of the receiver.

There may be some options for plug-ins or "sidecar" add-ons to augment the processing power of the STB as time progresses, provided that the requirement is foreseen and a suitable interface is provided.

Until recently, it has proven difficult to consult with the creative conventional programme-making fraternity on what they would do with interactivity if they had the option. Such people are usually focused on today's problems. There are signs now, however, that today's problems are the planning of programmes and services for new digital delivery media. Many broadcasters have launched, or are launching, satellite digital services, and digital terrestrial services are set to begin in 1998. Given that the technology readily provides interactive functions, the programme-makers are now getting down to planning what to use them for.

In the broadcasting environment, there is an understanding that the public must be encouraged to take up new services at their own pace, and not at the breakneck speed of the PC hardware/software upgrade cycle. It is expected that the introduction of interactive services and features will benefit from a step-by-step phased introduction over a relatively long period. This will permit time for corrective feedback as experience is gained, and will avoid confusing the viewer with too rapid a change-over from passive to interactive

viewing. Possible phases in the introduction of interactivity can be separated between stand-alone and programme-related additional features:

Stand-alone additional services – stages of phased introduction:

- much improved look and feel for teletext, making use of the processing and display facilities of MPEG technology, and with some source material collected from the Web;
- development of a parallel stream of loosely programme-associated information, created in an Internet authoring environment to provide a new-look "push" information service (i.e. control of programme and service selection will be included);
- introduction of a return / interaction channel to permit ordering and payment for products and support packs, for voting and for multi-household game play;
- interaction path used to personalise requests for information (local weather, traffic etc.);
- full Internet access with the advantage, when compared with modem-dialled calls, of rapid downloading of popular pages.

Programme-related interactive services – stages of phased introduction:

- provision of static information database which can be accessed without reference to programme broadcast time;
- some loose synchronization of dynamic information to track the programme during broadcast presentation;
- tight time synchronization for such material as play-along quizzes;
- use of return path to enter a community quiz show or national competition.

A number of issues must be tackled during the development of interactive programming, and the education of the viewing public to make use of the additional features. For instance, a linear programme with interactive features must still be engaging as a linear programme on its own. Interactivity could divert audiences away from a (carefully-) scheduled sequence of programmes, and a programme event could elicit a very large audience interaction at a certain moment (return path overload).

At the editorial level there are also many issues to be addressed. Content production is expensive, and the addition of interactive features is likely to add a significant extra cost. Re-use of material and single authoring for multiple delivery options will be important to keep down the overall programme costs. The presentation of material on a TV set may need a different design approach to that on a PC. The best ways of handling the sheer size, speed and interest of an interactive audience need to be planned for carefully.

5.4. Different national environments

The introduction of digital broadcasting services in Europe has exposed clear differences between countries. The pressure to introduce digital services has come mainly from pioneering operators who have started services to fill gaps they have identified in the broadcasting market in particular countries. There has been no simple pattern of introduction and, although a number of digital satellite services were expected to commence in 1995, they were all subsequently delayed for a number of reasons.

Once formally launched, the market for digital satellite services has been particularly successful and competitive in France where, historically, there was little analogue satellite penetration. Three services are offered from Canal+ (Canal Satellite), TPS (Television par satellite) and AB Sat. This compares with a much lower number of installations of digital satellite receivers in Germany over a similar period of time. Two factors which clearly differentiate between Germany and France are the very different levels of investment in cable, and the existing offer of analogue programming by satellite. In Germany, Deutsche Telekom has installed cable facilities massively over the last ten years to reach more than 80 % of the population; all terrestrial national and regional programmes are offered in simultaneous broadcast by satellite.

In the UK, analogue satellite services have been earning significant revenues for the major operator BSkyB, and it could be argued that early announcements of impending digital satellite service launches would have had an adverse destabilising effect on analogue STBs and subscription sales. In the event, BSkyB plans to launch digital services on Astra 2A (which has itself been delayed) in summer 1998. This new launch date may be linked more closely with the competition expected from digital terrestrial television services in late 1998, rather than to simple consumer demand. The launch plans for digital satellite in the UK do include a significant element of interactivity, and are notable by the creation of a strategic alliance known as BIB (British Interactive Broadcasting) formed from BSkyB in conjunction with British Telecom, a bank and a consumer equipment manufacturer.

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At the EBU, Mr Wilson was responsible for co-ordinating developments in data broadcasting technology. From the commencement of the DVB Project in 1993, he has been closely associated with many aspects of its work and until the end of 1997 was Head of the DVB Project Office. Ed Wilson is presently concentrating his attention on helping to implement DVB terrestrial services as Project Manager of DigiTAG (the Digital Terrestrial Television Action Group).

Quite different commercial and political situations exist in other European countries.

6. Conclusions

There is a range of technologies and protocols possible for introducing "interactive television" in its widest sense. There are no ways of predicting with certainty which will be successful, and those which will not be. The best that can be done at this time – or probably at any other time in a climate of rapid technological evolution – is to identify which routes seem to offer the greatest prospect of success.

The successful introduction of a new technology relies on the combined strength of the *technology*, *infrastructure* and *content*. The strength of content is particularly important and must be measured in terms of the difference between the new system, and what is already available.

There may well need to be different formulae to achieve success in *different geographical areas*, because the already-available content and the available infrastructure will be different. This will condition the shape and strength of the success pillars. For example, in general terms, the tradition for using the written word (literature) in leisure activities is greater in Northern Europe than in Southern Europe. There is also considerable disparity in the available delivery infrastructures for interactive systems, differences in telephone tariffs, etc.

There may well be different formulae needed for success within a given national or local environment, since distinct *patterns of behaviour* are emerging for media systems within a given society. One recent classification separates the national user audience into four groups who exhibit different media behaviour:

- knowledge workers;
- time-constrained individuals;
- leisure seekers;
- PC enthusiasts.

Each of these may be attracted to interactive services, to a greater or lesser extent.

In order to be successful, an interactive system will need a sensibly-sized mass audience – it must be of value to at least one, and preferably more than one, of the user groups mentioned above. It also probably needs to be of interest to more than a single European state, in order to benefit from mass sales.

An important starting point for an analysis needs to be *content*. The essential issue for the user is content: *what type of content, and at what cost, would deliver sufficient added value for one or more of the user groups mentioned above, in more than one European State?*

The evidence gathered from field trials of the full service networks is ambiguous. Although thsee trials have certainly not failed, the fact that no permanent Services-on-Demand have yet been announced suggests that "interactive television", in the sense of broadband services-on-demand, will take many years to arrive in Europe. However, there may well be a non-uniform take-up of the system across Europe.

The evidence of the universal success of the World Wide Web is clearer. It shows that, given that the infrastructure is available and that a sufficient range of content is available which cannot be obtained conveniently by other means, there is a large body of users who will adopt the new technology.

Lying between on-line services on the one hand and normal linear television broadcasts on the other hand is the interactive television "nebula". Services which are most likely to succeed could be expected to be those which draw on, and exploit, the proven features of broadcasting and on-line. These are likely to be the constellation points in the nebula, and the ones that deserve most attention.

Since the Internet is a demonstrably popular service, and equally this is the case for broadcast television, we are drawn to the conclusion that the most successful route is via services that combine these two. This might be called *Internet Television*.

Services that provide for viewers the option of linear programmes coupled with fast access to the Web seem currently to offer the greatest chance of success.

The DAVIC project has developed protocols for broadcast services that combine television with Web features. These are the *Enhanced Digital Broadcast Contour* — which allows for down-loadable Web pages that can be locally interactive in the receiver — and the *Interactive Digital Broadcast Contour* which allows for down-loadable Web pages and for an additional Internet connection that can be used at the same time as the programme. The latter contour is thus critical to the success of interactive television.

The services which are most likely to succeed will be those which cannot be found elsewhere and which are highly desirable. These are likely to include services that link the programme content itself with the Web pages. This would include audience interaction for quiz shows, commerce and additional information.

In an environment where much use of the Web services is made via an IDB system, the television programme provider would occupy a particular *position of strength* in capturing and holding the audiences. He may also be able to occupy a *dominant position* as an Internet Service Provider if he so wishes.

The delivery system for the Internet interaction channel may be:

- PSTN;
- ISDN;
- a UHF terrestrial broadcast forward-and-return channel;
- cable networks with return channels in the low-frequency band;
- V-SAT via collector, or another network.

The most viable system to use may depend on the available national infrastructure. For example, some broadcasters do not have the option of using PSTN because of the lack of universal availability of telephone lines.

Given that a country does have a well-developed and reliable PSTN service, this *will probably offer the route to interactivity with the lowest infrastructure costs*. In this case, the system could evolve to an ISDN-based system, as ISDN became implemented. The attractiveness of the service would be severely hampered if the cost of local access to the Internet server is anything more than marginal.

Given that a country or area has a *less well-developed or less reliable PSTN service*, the use of a *terrestrial UHF return*

channel system may present a viable option. If a *cable system* were available, this would clearly be the best infrastructure to implement the interaction channel.

An Interactive Digital Broadcasting system is likely to be of most interest to "knowledge workers", "time-constrained individuals" and "PC enthusiasts" rather than "leisure seekers". Over a period of time, the service use may spread to a greater proportion of leisure seekers, as succeeding generations become more computer literate. Nevertheless, in the initial phases of an interactive service, it seems reasonable to concentrate on using the interactivity for programme-related items that would appeal to the three early user groups.

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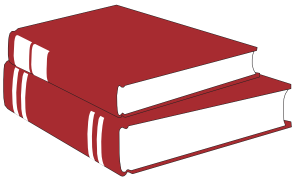
The introduction of DAB and the Europe of DVB-T

At the last meeting of the Technical Assembly (in April 98), the following statement on DAB was issued:

The EBU technical and radio-Europe communities have strongly supported the development of digital audio broadcasting in Europe. A range of existing and exciting new DAB services are available in different parts of Europe. The stage is set for rapid growth of this important new medium. To match the initiatives already made by broadcasters, the manufacturing community must rise to the challenge of making DAB receivers available at prices within reach of the general public. The success of DAB will now depend on the energy of the consumer electronics industry. What happens with DAB will also influence the way that new technologies are approached and introduced by the broadcasters in future. For DAB services to have value, affordable receivers must be available to the general public.

EBU Members have supported the development of the DVB-T system for digital terrestrial television broadcasting, which has a different purpose and different design objectives to DAB. The two systems are complementary, and they will each serve different aspects of the future media landscape. Each has different strengths and both are needed. Broadcasters will offer both DAB and DVB-T services, and there will be a public demand for both types of receiver.

The delivery of multimedia to mobiles is an issue that is currently under study in EBU Project Group B/MM (Mobile Multimedia), chaired by Kjell Engströem (SR).



Bookshelf

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For further information about all other publications reviewed here, please contact the respective publisher.

The formative years of television

This is the 22nd volume in the IEE's *History of Technology* series. Several volumes in the series have dealt with radio and television. The author, Professor R.W. Burns, has already contributed to the series with his two books, *British Television, the formative years* and *Radar developments to 1945*.

The present volume shows all the hallmarks of intensive research. It covers the period from 1878 to 1940. Television in 1878? Well not quite. Professor Burns commences his history at a time when the first man-made images were emerging. In Chapter 1 he even goes back to the days of the Shadow Theatre and the Magic Lantern. The most likely starting date for the development of television as we know it today was probably when the photoconductive properties of selenium were discovered at the transatlantic cable station at Valencia Island on the south-west coast of Ireland. That was in 1873. This discovery stimulated many scientists and engineers to experiment with the possibility of "sending images by electricity".

Chapter 5, entitled "Distant Vision" deals with the period between 1880 and 1920. In this present day of multimedia and interactive television, it is interesting to see a reproduction from the National Archives in Washington, showing "A 19th Century Impression of two-way Television in the year 2000 AD". This is a pen sketch of a family who are viewing a large-screen television (high definition, no doubt) with a camera, microphone and ear-piece in place, to allow two-way video and audio communication. Forecasting the future of television has been a favourite pastime down through the years.

Professor Burns refers to the play by George Bernard Shaw "Back to Methuselah" which portrays Government Ministers at different locations in the year 2170, holding a conference by means of what we now call "videoconferencing".

The book goes on to describe the pioneering work of the 1920s and early 30s which was the most important time in the development of television. The work of John Logie Baird in the UK is dealt with in some detail as is the contribution of Shoenberg and others at EMI. This part of history is, of course, already covered in the author's previous book. The most interesting new material, at least for European readers, is that which refers to the developments elsewhere in Europe, in Japan and in the United States.

A system of television, based on the Nipkow Disc, was demonstrated at the 1929 Berlin Radio Exhibition by an engineer of Hungarian origin called Mihaly. With a resolution of thirty lines, this system was generally acceptable. His images were broadcast daily from a local Berlin transmitter (on a wavelength of 475.7 m). Following his success in Germany, Mihaly sought to have his system demonstrated in Britain but, despite his best efforts, he failed to get support from either the British Post Office or the BBC.

The Olympic Games of 1940 were to have been held in Tokyo and NHK, the Japanese national broadcaster, was preparing to televise the games and to transmit the events over an area within a 12 miles radius. NHK had already set up a research laboratory and had allocated a considerable amount of money to engineer a system of "high-definition television" for the Games. The outbreak of war in Europe in 1939 put an end to the Japanese plans.

The description of developments in the United States is, by far, the most interesting part of the book. Much of the material, at least as far as this reviewer is concerned, is based on recent research. Of course the work of the well-known television engineers of the day is well chronicled. The outstanding one was Dr V.K. Zworykin whose iconoscope camera tube created the fundamental element in the electronic television chain. The book deals at length with the work carried in the laboratories of Westinghouse and the Radio Corporation of America.

Of particular interest is the amount of coverage given to the work of Dr E.F.W. Alexanderson. Dr Alexanderson (a relative of the EBU Radio Director, Thomas Alexanderson) is better known as the inventor of the alternators used by Marconi in his radio telegraph transmitters in the early part of the century. Ernst Alexanderson was a Swedish engineer who emigrated to the United States as a young man. An employee of the General Electric Company, he became a key figure in the development of the high-frequency alternators used in wireless transmitters. His developments led to the formation of the Radio Corporation of America (RCA) where he served as Chief Engineer for many years. He started his work on television in 1924 and was an advocate of large-screen projection.

This book of some 660 pages represents an important contribution to the his-

tory of broadcasting and should be essential reading for those interested in the origins of our profession. It can proudly take its place beside the other 21 IEE volumes which record the history of technology.

Television: An international history of the formative years
IEE History of Technology Series, No. 22
R.W. Burns
Hardbound volume of 661 pages
The IEE in association with the Science Musem, London, 1998
Ref: ISBN 0 85296 914 7. Price: £75.00.

George T. Waters

Stereophonic sound recording – theory and practice

Readers of this excellent book should be aware of the potentially misleading title of the English edition. The term "sound recording" can be used in different contexts and, in this case, readers should not expect a book that gives technical details of recording formats.

The scope of the book is well defined in Chapter 2 as the:

- operation during which the microphone modulation and sound quality is adjusted in order to be transmitted or recorded.
- set of procedures, the aim of which is to create spatial sound perception through the picking up of sound sources and the use of electro-acoustic equipment.

The book is an operational guide to the techniques used in sound production for recording or broadcasting. It covers the various techniques used to capture and process the sound, and the treatment of the subject is very practical and down to earth. Both authors have considerable experience in the broadcasting and recording industries. They have not aimed to dictate solutions, rather to explain the reason for the variety of methods suggested and to let the reader decide how he or she can exploit them in their daily work. There is very little mathematics in the book but the authors do not avoid the use of theoretical explanations where this is necessary to understand the techniques they describe.

They are concerned essentially with live sound, i.e. actual performances taking place in real spaces, rather than heavily-processed material. After a brief non-technical review of the history of recording, they deal with the basic concepts of the profession, both technical and operational. After sections on sound and acoustics, and the preparation of recording sessions, they move on to the central theme of the book which is microphone techniques. These are explained with the help of many clear diagrams.

The book also contains useful glossaries, and a section which cross references the often confusing and overlapping titles, functions and training of the personnel in different countries, different industries and the different branches of these industries.

For both students and practitioners, this book is a comprehensive introduction to its subject and should remain a valid reference work to the "art and mystery" of sound capture.

Stereophonic Sound Recording: Theory and Practice
Hugonnet and Walder
Hardbound volume of 291 pages
John Wiley and Sons, Chichester, UK,1998
Ref: ISBN 0-471-97487-0. Price: £29.95.

Richard Chalmers

Digital audio and video

This book provides a wide range of background information for the student, or the broadcast practitioner, in the technology of current television and radio broadcasting systems. The ground it covers includes systems for both programme production and programme delivery. Good summaries are given of current analogue television systems, as a launchpad into digital technologies.

Chapters in the book describe basic digitalization concepts, video fundamentals, audio fundamentals, audio-video production systems, analogue-to-digital conversion, video cameras, digital transmission (including some practical aspects of digital receivers), digital signal processing, data compression, video displays, digital recording, post production and digital multimedia. The book also reviews, in summary form, the new delivery issues such as the World Wide Web and video-on-demand. A glossary of terms is also included.

Although the book does not enter into detail in many areas, it does nevertheless provide a useful and relatively clear introduction to the current world of broadcast technology. To some extent, it has been written from a US point-of-view but, in spite of this, it should still be of interest to readers in other parts of the world.

Principles of Digital Audio and Video
A.C. Luther
Hardbound volume of 405 pages
Artech House, London, 1997
Ref: ISBN 0-89006-892-5. Price: £60.00.

David Wood

ATM

This comprehensive book in German has been written by two experts from Siemens, Germany. It comprises 11 chapters and two appendices, and contains 173 illustrations. All 259 literature references are detailed at the end of the book.

Chapter 1 puts ATM, which is the basis of Broadband-ISDN, into the context of past and future international developments for digital telecommunication infrastructures. Chapter 2 describes the basic concepts of ATM technology, while Chapters 3 and 4 deal with the system architecture and the protocol layers in quite some detail.

Distribution and statical multiplexing are covered in Chapter 5, while the following four chapters deal with ATM network concepts and routeing, applications, service concepts and network structures. ATM connections are described in Chapter 10.

Chapter 11 explains fundamental principles and protocols; these represent knowledge that is necessary to understand the previous chapters. The two appendices provide a comprehensive listing of the ATM standards and specifications of a number of specialized agencies and also of the ATM Forum (founded in 1991 and still in existence). Included here are those specifications that were still in the drafting stage at the time of writing. There is also a list of abbreviations used in the book.

The book is well written and aims to provide high-level multimedia telecommunication managers in the computer and switched network industries with sufficient technical detail for self-study. Relatively little technical knowl-

edge is needed to start reading this most useful book.

ATM – Infrastruktur für die Hochleistungs-kommunikation
E. Rathged and E. Wallmeier
Hardbound volume of 535 pages
Springer, Berlin, 1997
Ref: ISBN 3-540-60370-0. Price: DM 178.

Dietmar Kopitz

Non-linear video buyers guide

It seems like only yesterday that we reviewed the *Non-linear Video Buyers Guide* from Sypha. It was, of course last year, and now there is a 4th edition, dated April 1998.

The new 4th edition gives details of over 500 non-linear editors, hybrid editors, disk recorders and video servers. On-line and off-line editing systems, of various quality and cost, are included: complete systems, plug-in cards for computers, and software packages. Seperate sections deal with random-access disk recorders and servers. The technical information provided covers target usage, hardware and software specifications and requirements, operational features, EDL / data management and files, and support for networking and import / export of media files. Also covered are future development plans, typical configurations, costs and details of suppliers. As in the previous edition, there is advice on assessing storage requirements, together with useful vocabularies and explanations of specialist terms.

In this rapidly developing field, even a yearly guide may seem too infrequent but the compilers of this guide have made a valiant attempt to persuade manufacturers to give advanced notice of their new products.

The Non-linear Video Buyers Guide
Edited by Y. Hashmin
Bound volume of 104 pages
Sypha Publications, London, 1998
Ref: ISBN 1-901950-00-X. Price: £22.50.

Richard Chalmers

Assessment of sound programme material

"Listening" is an integral part of all sound and television programme-making operations. The human ear alone is able to judge the aesthetic or artistic quality of programme material and, indeed, certain aspects of the technical quality. However, to permit the ear to make fair and unbiased judgements, it must be allowed to function under favourable conditions.

The listening conditions specified in this second edition of EBU document Tech. 3276 are essentially relevant in the following two situations:

- *Reference listening rooms:* listening rooms used for the critical assessment and selection of programme material for inclusion in a sound or television broadcaster's programme output.
- *High-quality sound control rooms:* sound control rooms used for the critical assessment of sound quality as a part of the sound or television broadcast production process.

The accuracy and quality of listening conditions depend on the relevant sound-field parameters that affect the ears of the listener. Their definition will pose a number of design constraints upon the characteristics of the loudspeakers used for monitoring, and the properties of the listening room. It may be noted that, in the case of headphone listening, the properties of the room have practically no influence on the listening conditions.

The main part of the document sets out the basic requirements for the sound-field parameters. Four *Appendices* then give recommendations on ways in which these requirements can be met.

To a greater or lesser extent, the listening conditions given here may inspire the implementation of listening facilities in other contexts – such as programme fairs, the assessment of programmes in competitions and the subjective testing of the technical quality of sound systems.

EBU – Listening conditions for the assessment of sound programme material: monophonic and two-channel stereophonic (2nd edition)
EBU document Tech. 3276
EBU, Geneva, 1998
Price: 70 Swiss francs.

New RDS book due soon

A new book on RDS called *RDS – The Radio Data System* will be published by Artech House later this year, written by Dietmar Kopitz and Bev Marks, who are both still working on RDS technology for the EBU, the RDS Forum and also for the European Commission as far as RDS-TMC is concerned.

The contents of this new book will include:

- RDS system and applications overview;
- Differences between RDS and RBDS;
- Summary of changes in the latest specifications;
- RDS features serving as tuning aids;
- Radio programme-related RDS features;
- Traffic information services;
- Intelligent Transport Systems and RDS-TMC;
- Basic and Enhanced FM Radio Paging;
- Open Data Application (ODA, AID);
- Differential GPS;
- RDS encoder communication protocols and the Universal Encoder Communication Protocol;
- RDS demodulators and decoders;
- Outlook – RDS in comparison with other radio broadcast data systems;
- Modulation of the RDS data signal;
- RDS data decoding;
- RDS reception reliability;
- Required data repetition rates for programme-related features;
- RDS data transmission capacity limits;
- PI coding in RDS and RBDS;
- RDS country or area identification codes;
- PTY display terms in several different languages;
- Character sets for alphanumeric display;
- Implemented RDS features in various countries;
- Web-site of the RDS Forum;
- UECP message commands;
- Glossary of terms and abbreviations.

The book will have some 350 pages and will be the first authoritative guide to the introduction of RDS-TMC services required by the European Commission. The ISBN will be 0-98006-744-9.

EBU Technical Review will publish an independent review of this new important text on RDS, after it has been published at the end of this year.

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EBU Catalogue of Publications *(May 1998 edition)*				**A**	
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European Standards . . . for broadcasting

European Telecommunication Standards (ETSs), ETSI Technical Reports (ETRs) and CENELEC Standards (ENs) that have been approved through the Joint Technical Committee of the EBU, ETSI and CENELEC are available from EBU Publications.

Please use the order form on page 45, making sure that the reference number of each required Report / Standard is clearly shown.

Ref. no.	*Title*	*EBU price category*
Data broadcasting		
ETS 300 231	Television Systems; Specification of the domestic video Programme Delivery Control system (PDC)	F
ETS 300 706	Enhanced Teletext specification	G
ETR 287	Code of practice for enhanced Teletext	C
ETR 288	Code of practice for an Electronic Programme Guide (EPG)	D
Digital Audio Broadcasting (DAB)		
ETS 300 401 (Edition 2)	Radio broadcasting systems; Digital Audio Broadcasting (DAB) to mobile, portable and fixed receivers	G
ETS 300 799	Digital Audio Broadcasting (DAB); Distribution interfaces; Ensemble Transport Interface (ETI)	E
Digital Video Broadcasting (DVB)		
ETS 300 421	Digital broadcasting systems for television, sound and data services; Framing structure, channel coding and modulation for 11 / 12 GHz satellite services	C
ETS 300 429	Digital broadcasting systems for television, sound and data services; Framing structure, channel coding and modulation for cable systems	C
ETS 300 468 (Edition 2)	Digital Video Broadcasting (DVB); Specification for Service Information (SI) in DVB systems	E
ETS 300 472 (Edition 2)	Digital Video Broadcasting (DVB); Specification for conveying ITU-R System B Teletext in DVB bitstreams	C
ETS 300 473	Digital broadcasting systems for television, sound and data services; Satellite Master Antenna Television (SMATV) distribution systems	C
ETS 300 743	Digital Video Broadcasting (DVB); Subtitling systems	D
ETS 300 744	Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for digital Terrestrial television (DVB-T	D
ETS 300 748	Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for MVDS at 10 GHz and above	C
ETS 300 749	Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for MMDS systems below 10 GHz	C
ETS 300 801	Digital Video Broadcasting (DVB); Interaction channel through Public Switched Telecommunications Network (PSTN) / Integrated Services Digital Networks (ISDN)	C

Ref. no.	*Title*	*EBU price category*
ETS 300 802	Digital Video Broadcasting (DVB); Network-independent protocols for DVB interactive services	C
ETR 154 (Edition 3)	Digital Video Broadcasting (DVB); Implementation guidelines for the use of MPEG-2 Systems, Video and Audio in satellite, cable and terrestrial broadcasting applications	C
ETR 162	Digital broadcasting systems for television, sound and data services; Allocation of Service Information (SI) codes for Digital Video Broadcasting (DVB) systems	C
ETR 211	Digital broadcasting systems for television; Implementation guidelines for the use of MPEG-2 systems; Guidelines on implementation and usage of service information	C
ETR 289	Digital Video Broadcasting (DVB); Support for use of scrambling and Conditional Access (CA) within digital broadcasting systems	C
ETR 290	Digital Video Broadcasting (DVB); Measurement guidelines for DVB systems	F

Radio broadcasting systems

ETS 300 751	Radio broadcasting systems; Systems for Wireless Infotainment Forwarding and Teledistribution (SWIFT)	E

Radio Data System (RDS)

EN50067:1996 (Edition 2)	Specification of the radio data system (RDS)	D

Television systems

ETS 300 163	Television systems; NICAM 728: Specification for transmission of two-channel digital sound with terrestrial television systems B, G, H, I and L	C
ETS 300 250	Television systems; Specification of the D2-MAC / Packet system	G
ETS 300 294 (Edition 3)	Television systems; 625-line television: Wide Screen Signalling (WSS)	C
ETS 300 352	Television systems; Specification of the D2-HDMAC / Packet system	G
ETS 300 355	Television systems: Specification of the D-MAC / Packet system	G
ETS 300 708	Television systems; Data transmission within Teletext	C
ETS 300 731	Television Systems: Enhanced 625-line Phased Alternate Line (PAL) television; PALplus	H
ETS 300 732	Television Systems: Enhanced 625-line PAL / SECAM television; Ghost Cancellation Reference (GCR) signals	C
ETR 140	Television Systems; Allocation of Service Identification (SI) codes for Multiplexed Analogue Component (MAC) / Packet services	B

Transmitting stations

ETS 300 384	Radio broadcasting systems; Very High Frequency (VHF), frequency modulated, sound broadcasting transmitters	C
ETS 300 750	Radio broadcasting systems; Very High Frequency (VHF), frequency modulated, sound broadcasting transmitters in the 66 to 73 MHz band	C
ETR 132	Radio broadcasting systems; Code of practice for site engineering Very High Frequency (VHF), frequency modulated, sound broadcasting transmitters	E

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10th meeting of the EBU Technical Committee

Geneva, 17 & 18 February 1998

The Chairman, Prof. U. Messerschmid (ARD / ZDF / IRT), welcomed Mr Guennady K. Kachalov, the new representative of RTR. The Technical Committee was then briefed by Mr Kachalov on the current situation regarding national broadcasting in Russia.

EBU Activity Review

An Activity Review is currently being undertaken by the Administrative Council and the Presidency to analyze the tasks and priorities of the various EBU Committees. Mr Philip Laven (EBU) explained that, following the last Technical Committee meeting in October 1997, a synthesis of its discussion on this subject was prepared and submitted to a meeting of the Presidency in December 1997. The Technical Committee synthesis was well received by the Presidency.

The next phase of the study will be for the Technical Committee to study its priorities and those appropriate for the Technical Department, in the light of a breakdown of the Technical Department's costs for 1997. These may be available at the meeting of the Technical Committee in April 1998.

The Technical Committee discussed its own "management structure" which comprises the *Technical Assembly*, the *Technical Committee* and the three *Management Committees* (BMC, NDC and PMC). When considered globally, this structure can be seen as expensive and time-consuming and, in some cases such as for the Technical Assembly, the purpose of the group is not always clear. The Technical Committee concluded that, at least as far as the Management Committees are concerned, a more cost-effective structure was not evident. Furthermore, it was concluded that their efficiency probably depends on maintaining the current levels of support from the staff of EBU Headquarters in Geneva.

Liaison with the Television Committee

Mr Arie Smit (NOS) and Mr Laven represent the Technical Committee at meetings of the Television Committee. They reported that the Television Committee devoted considerable time at its last meeting to the Activity Review, but it continues to give a low priority to strategic matters, because other issues continue to dominate the agenda.

Liaison with the Radio Committee

Mr Daniel Sauvet-Goichon (GRF / TDF) and Mr David Wood (EBU) attend the Radio Committee meetings on behalf of the Technical Committee. There are several subjects that are likely to be presented to future meetings of the Radio Committee, and these include *satellite radio* and *watermarking*.

At its last meeting, the Technical Committee proposed to allow the Radio Committee to take the lead in establishing a Multimedia Forum (from an original BMC idea), to exchange information about potential multimedia applications. The Radio Committee has taken this further and will study a more detailed proposal for such a Forum in March 1998. Technical involvement in the Forum will be requested.

Inter-Union Technical Committee (IUTC)

The Inter-Union Technical Committee will meet just before the next meeting of the Technical Committee in April. The Technical Committee reviewed the draft agenda for that meeting, and suggested that a principal topic for discussion should be on the future tasks and role of the IUTC. It will also be necessary to nominate a new Chair and Vice-Chair for the IUTC at the forthcoming meeting.

Broadcast Systems Management Committee (BMC)

Mr Jan Doeven (NOS / NOZEMA), Chairman of the BMC, reported on recent activities in the BMC with reference to the report of the last meeting, which was approved. The Technical Committee approved the nomination of Mr Kjell Engströem (SR) to the BMC, and suggested that Mr Doeven should invite Mr Juha Vesaoja (YLE) as a guest to attend the BMC meetings for the remainder of this year, pending the appointment of the new BMC membership for 1999 / 2000.

The Technical Committee will need to decide on the complete memberships of the three Management Committees for the next two-year period, at its meeting in October. The Chairmen of the Management Committees were invited to make suggestions.

The Technical Committee accepted the membership tier proposals of the BMC which are as follows:

- normal members, who are from EBU member organizations;
- members from outside organizations, where this is of value to the work, and who are acceptable to the EBU members of the group;
- electronic members (members who are on an e-mail list).

The BMC requested that, while appreciating the merits of publishing the EBU Technical review in electronic form, the paper versions should be maintained.

A number of groups were disbanded at the last meeting, and new groups were created. The new groups created were **B/CAI** (Implementation of the Chester agreement on digital terrestrial television frequency planning) and **B/RFI** (successor to B/EMC, examining the effects of exposure to RFI). The groups disbanded were B/SVP, B/SAP, B/TVP, B/EMC, and B/TCPD. The overall status of the BMC groups is given in the adjacent *Table*.

Mr Doeven pointed out that the closure of B/SVP, and the lack of interest in setting up a new project group on satellite broadcast planning, was a historic change of perspective for the EBU.

The Technical Committee discussed the work of B/CASE that is shortly to include a comparison of the MPEG-2 and AC3 audio-coding systems at different bit-rates. This is likely to be a sensitive matter because of the commercial implications of the results.

The Technical Committee considered the proposal from the BMC to establish a multi-disciplinary activity on the "tailoring" of multimedia packages to suit different delivery means. The Technical Committee agreed that the work should go ahead. However, for administrative simplicity, this could be a BMC Project Group with strong participation from the PMC and other specialists when needed. The BMC was asked to prepare a guidelines document for the next meeting of the Technical Committee.

Mr Doeven explained that there would be an annual meeting "Forecast 98" in the second week of October 1998. A previous proposal for a Specialized Meeting on the future of radio has been deferred until 1999. There should, however, be a Specialized Meeting on DAVIC progress later in the year.

Project Group	Subject	Status	Follow-up
	System development		
B/API	API	Continue	
B/CASE	Sound coding	Continue	
B/DAVIC	DAVIC support	Continue	
B/MM	Multimedia to mobiles	Continue	
B/WB	Broadcasting via WWW	Continue	
B/TPEG	Traffic information	Continue	
B/PCS	Parental control systems	Review in April 98	
Total number of remaining groups = 7			
	Frequency planning		
B/TAPI	DAB implementation	Continue	
B/TDP	Propagation	Continue	
B/DSI	Long-term Frequency Management.	Disbanded	
B/EMC	Electromagnetic compatibility	Disbanded	See B/RFI
B/SAB	Ancillary broadcasting	Disbanded	See B/CAI
B/SAP	S-DAB planning	Disbanded	
B/SVP	Satellite TV planning	Disbanded	
B/TVP	DVB-T planning	Disbanded	See B/CAI
B/TPCP	TV planning software	Disbanded	
B/RFI	Radiation	New	
B/CAI	DVB-T implementation	New	
B/INB	International broadcasting	Review in April 98	
Total number of remaining groups = 5			

BMC Groups – February 1998.

Production Technology Management Committee (PMC)

Mr Maurizio Ardito (RAI), Chairman of the PMC, described recent developments within the PMC with reference to the report of the last meeting, which was approved. Some of the elements highlighted were as follows.

The P/AFT Group is co-operating with the AES in the development of audio metadata systems. The PMC is strongly encouraging the group to ensure consistency with the metadata work of the EBU/SMPTE Task Force.

The Task Force itself continues to increase in membership, mainly drawn from new manufacturers. There will be a major report available at the time of this year's NAB Convention, but there will remain many problems to solve subsequently, and the work will need to continue.

There will be an EBU/SMPTE meeting during NAB to discuss future administrative arrangements for the work. A continuation of the close co-operation will be sought, based on an appropriate new structure (hopefully involving more users) to be agreed with the SMPTE.

The Task Force has agreed two "interchange" formats for compressed video, as agreement on a single system was not been possible. However, there is now a proposal to add a third format (Motion-JPEG) which, though widely used as a concept, presents itself in a variety of generally non-compatible forms. The EBU has adopted a statement against the inclusion of this format.

The recent Seminar organized by the PMC in Geneva – on the applications of packetized television in the light of the Task Force work – was a great success, both technically and financially.

The attendance was 173, of which more than 100 delegates came from EBU Members.

The PMC approved the report by P/DTR on the Digital S-format evaluation, which will soon be available to EBU Members. The quality of this format is similar to that of digital Betacam. The group will also test the 50 Mbit/s versions of the SX and DVCpro formats, as well as the faster-than-real-time transfer of compressed signals. It will additionally prepare the requirements for the use of DVD in acquisition. This work is timely because a committee in Japan is preparing a standard for a camcorder system which uses DVD as the recording media, and it has asked the EBU to take part in this work.

The Technical Committee asked that the planned work of the PMC should be broken down into tasks. Once a task has been completed, the group should be formally disbanded. New groups can be created with similar memberships, but the work should not be seen as an ongoing study. Mr Ardito said that, for present activities, P/DTR can function without secretarial assistance from the Technical Department. A meeting is planned only when all tests have been completed.

The PMC will open a new Project Group, with specialist sub-projects, to deal with archives.

The PMC also plans to open a Project Group to investigate the end-to-end quality-of-service requirements of a digital environment, as they are often not well understood in the production and archiving areas. This will necessarily include contribution circuits. The Technical Committee concurred that liaison needs to be arranged with the NDC in this area.

EBU Network Development Committee (NDC)

Mr Dat Pham Tat (GRF/TDF), Chairman of the NDC, explained the work of the NDC with reference to the report of the last meeting, which was approved. Among the points described by the Chairman were the following.

A new Project Group, N/MT, has been formed, which will be led by Mr Herbert Hofmann (ARD/ZDF-IRT) to evaluate the use of MPEG for contribution and distribution.

Project Group N/Diginet has prepared a status report on Eurovision digitalization. This explains the transponder structure that will be used for digital services which utilize 24 Mbit/s and 8 Mbit/s slots.

The Technical Committee asked what arrangements would be made for the Eurovision Operations Division to meet the Technical Department's cost for work related to Eurovision. Mr Laven expected that the Eurovision Operations Department would provide some funding from 1999 onwards.

This year the work of the N/VSAT Group will be completed. A problem arose in the approval of the receiving dish but this has now been solved.

The N/Services Group prepared a list of potential new services that could be provided by the digital Eurovision network. These were discussed with the Television Operations Department, who agreed that three of these services were worthy of action, but asked that some should be discussed first with the TV department, whilst others were thought not to be of short-term interest. Mr Pham Tat regarded this as a reasonable response to the proposals.

The Technical Committee recognizes the value of the work done by N/Services, but some members feel that the Operations Department is being unduly conservative in examining new services that could provide a competitive advantage for Eurovision, and help to safeguard its future. Mr Pham Tat offered to provide a summary of the new services for the Technical Assembly.

The Technical Committee agreed to the deletion of the EBU Recommendation of 1993 in favour of the ETSI 34 Mbit/s system, following the choice by Eurovision of the MPEG-2 system.

European co-ordination groups

Referring to the High Level Strategy Group (HLSG), Mr Laven reported that attendance by the EBU in full strength (4 members) had not yet been possible. The discussions in the HLSG were not well focussed on strategy but, bearing in mind that the committee is quite highly considered by the European Commission, the EBU should continue to participate. The ICT-SB (Information and Communications Technology Standards Board) continues to be distracted by territorial standardization disputes.

Implementation and pre-standardization groups

DigiTAG

Herman van Wijk, Chairman of DigiTAG, gave a presentation on current developments. He was strongly in favour of better collaborative arrangements between the EBU and DigiTAG. This may be achieved when a new, already-planned, EBU User Group has been set up.

Liaison and inter-disciplinary groups

I/EPGDB

The Inter-disciplinary Group on Electronic Programme Guides produced a report at the end of 1997 and this has now been published (BPN 015). The group is moving on to create a User Group on EPGs and other applications, and there will be an inaugural meeting in May 1998. In addition, the group is examining how it can help in the API situation.

The BMC also has a Project Group B/API, which is evaluating the different API systems from a technical viewpoint. The Chairman of this group, Mr Wolfgang Graf (ARD/ZDF-IRT) suggested establishing a pan-European co-ordination Forum ("MESA") to implement migration from today's APIs to a unique European API, once it has been agreed.

The I/EPGDB Group discussed this proposal with Mr Graf, and received advice from Mr Doeven. They concluded that it was not necessary to establish a new Forum, but rather that the work might be done by I/EPGDB in conjunction with B/API.

Initially there seem to be two potential migration strategies. The first is a multi-step process, involving software downloads, which will eventually result in a common system. The second is to establish how long it will be before the new API must be universally used and to ask the European institutions to help fund the additional costs incurred by the transition. The Technical Committee thought that probably neither of these is workable, though the first might work in individual countries.

I/EPGDB will probably meet with B/API during the summer to review the options, in the light of progress in the DVB project towards a common system.

EBU-ATSC Liaison Group

The EBU and ATSC (United States Advanced Television Systems Committee) normally arrange liaison meetings during the international broadcasting conferences (NAB, Montreux and IBC). In principle, a meeting had been scheduled for NAB and the discussions were to have included the receiver technology situation. After a poll, it seemed that few members of the current Technical Committee would attend NAB this year. If a reasonable delegation at NAB was not possible, it was suggested that the meeting might be rescheduled at IBC in September. However, it was also suggested that it may be timely to discuss with the ATSC whether the usefulness of the group is still sufficient to continue with it.

EBU-EACEM Liaison Group

This liaison group will meet formally in October 1998. Mr Laven reported that there were some intermediate discussions underway between the Technical Department and EACEM (European Association of Consumer Electronics Manufacturers), to develop ideas on how to make the EBU-EACEM liaison process more effective. It is possible that some proposals will arise from these discussions

Some members of the Committee thought it was probably timely to begin liaison formally with the computer industry, rather than solely with the consumer electronics industry.

Future EBU Conferences and Fora

A number of proposals for items for the Technical Assembly were made. Mr Laven and Prof. Messerschmid will make a final choice after considering the time available. The options include the following:

- a presentation on the results of the WARC 97 Conference;
- a presentation on the practical implementation of SFNs for DVB-T;
- a presentation on the latest API and EPG situation;
- an update on Webcasting and related areas;
- a review of the Green Paper and the EBU comments on it;
- a presentation of the archive system developed by RAI, with demonstrations;
- a series of presentations by members, giving the current status of digital implementation in their organizations;
- key developments in MPEG-4/MPEG-7 for broadcasting;
- progressive scanning and flat-screen receivers;
- conclusions and implications of the work of the EBU/SMPTE Task Force;
- a presentation on the potential evolution of Eurovision services (though this could be part of the NDC presentation);

In addition, time should be devoted to the Activity Review, and to an appraisal of the Technical Department's work.

The Technical Committee recognized that the role of the Technical Assembly needs to be reviewed. One suggestion was that its role may be to provide a review of key technologies from the perspective of the public service broadcasters.

Other business

Teleweb

Over the last two years, two new systems have been devised which involve Internet and analogue broadcast television. The first (*Intercast*) uses spare lines in the VBI to broadcast Web-compatible multimedia, which can be viewed on a specially-equipped PC. The second system (*Web TV*) uses a new set-top box to deliver Web pages (received via the telephone) to the TV screen.

At the EBU/EACEM Liaison Group meeting in October 1997, EACEM invited the EBU to take part in the development of a system to provide Web-compatible data via the VBI for home display on conventional television receivers. The EBU agreed to participate in the EACEM Group; the work has now moved on to a stage where EACEM wishes to develop the specification and to provide EBU bodies with system demonstrations. This is probably the moment when a serious decision about the system's future potential needs to be made.

The Technical Committee discussed this matter at length, taking into account a number of factors such as the projected life of analogue television, and the alternative mechanisms for providing such services. The Technical Committee's conclusions were that, although the work to date has been thoughtfully and carefully done, it is difficult to see a successful future for the system. Any investment in analogue television – which now has a finite life – must offer major new services. In fact there is only limited space in the vertical blanking interval for Teleweb data; Web TV systems will offer a much larger choice of Web pages and other services for home display on a conventional receiver. In summary, although the idea of Teleweb is interesting, on balance there does not seem to be a business case for its development. There thus seems little case for demonstrations to EBU bodies.

One option might be to try to re-focus the work toward digital Web delivery systems that rely on hard disk storage in the receiver.

Elections at the 4th Technical Assembly

Prof. Messerschmid announced that he will probably not wish to be considered for a further term of office as Chairman. He will continue with the Technical Committee until the end of 1998.

Progressive scanning

The Technical Committee considered the report of the small group set up at the last meeting to study progressive scanning. They thought it was very interesting and stimulating, and the report was approved. In addition, the Technical Committee asked the BMC to prepare guidelines for a new Project Group to deal with this subject (including PMC participation). Membership should include appropriate content experts if necessary.

Future meetings

The 11th meeting of the Technical Committee, hosted by PRT/TVP, will be held in Cracow, Poland, on Monday 27 April 1998, followed by the 4th Technical Assembly on 28 and 29 April.

The 12th meeting of the Technical Committee will be hosted by CSTA/CT in Prague, Czech Republic, on 6 and 7 October 1998.

For your diary . . .

EBU meetings, seminars and workshops

October	**Technical Committee (11th Meeting)** Prague, Czech Republic 6-7 October 1998	**Contact:** Geneviève Juttens Tel: +41 22 717 27 05 E-mail: genevieve.juttens@ebu.ch
November	**6th Eurotravel** Namur, Belgium 17-18 November 1998	**Contact:** Jean Pol Hecq Tel: +32 2 737 4023 E-mail: jhe@rtbf.be Web: //www.rtbf.be/eurotravel
December	**Seminar – New television technologies** Sofia, Bulgaria 3-4 December 1998	**Contact:** David Wood Tel: +41 22 717 27 31 E-mail: wood@ebu.ch
January	**Workshop – Programme archives for the year 2000** EBU Geneva, Switzerland January 1999	**Contact:** Jean-Jacques Peters Tel: +41 22 717 27 21 E-mail: peters@ebu.ch

Other meetings, seminars and workshops

October	**DVB – General Assembly** EBU Geneva, Switzerland 8 October 1998	**Contact:** Peter MacAvock Tel: +41 22 717 27 19 E-mail: dvb@dvb.org Web: //www.dvb.org
October	**World DAB Forum – General Assembly** Stockholm, Sweden 22-23 October 1998	**Contact:** Julie Unsworth Tel: +44 171 896 9050 E-mail: unsworth@worlddab.org Web: //www.worlddab.org
November	**RDS Forum – General Assembly** Namur, Belgium 16 November 1998	**Contact:** Dietmar Kopitz Tel: +41 22 717 27 11 E-mail: kopitz@ebu.ch Web: //www.rds.org.uk
December	**DigiTAG – General Assembly** EBU Geneva, Switzerland 3 December 1998	**Contact:** Edgar Wilson Tel: +41 22 717 27 33 E-mail: digitag@ebu.ch Web: //www.digitag.org

International conferences, exhibitions, workshops etc.

June	**HuMIDAB workshop on the user-friendliness of DAB services** London, UK 30 June 1998	**Contact:** World DAB Forum Tel: +44 171 896 9050 E-mail: unsworth@worlddab.org Web: //www.worlddab.org
September	**IBC98** Amsterdam, The Netherlands 11-15 September 1998	**Contact:** IBC Ltd Tel: +44 171 240 3839 E-mail: show@ibc.org.uk Web: //www.ibc.org.uk/ibc
December	**Cable and Satellite Asia 98** SICEC, Singapore 9-11 December 1998	**Contact:** Reed Exhibitions PTE Ltd Tel: +65 434 3675 E-mail: chuilan.chia@reedexpo.com.sg

EBU Active Members

(last update: January 1998)

Algeria
Entreprise Nationale de Télévision / Entreprise Nationale de Radiodiffusion Sonore / Télédiffusion d'Algérie

Austria
Österreichischer Rundfunk

Belarus
Belaruskaja Tele-Radio Campanija

Belgium
Vlaamse Radio en Televisie and Radio-Télévision Belge de la Communauté française

Bosnia-Herzegovina
Radio Televizija Bosne i Hercegovine

Bulgaria
Bâlgarsko Nationalno Radio
Bâlgarska NationalnaTelevizija

Croatia
Hrvatska Radiotelevizija

Cyprus
Cyprus Broadcasting Corporation

Czech Republic
Cesky Rozhlas
Ceská Televize

Denmark
Danmarks Radio
TV2/Danmark

Egypt
Egyptian Radio and Television Union

Estonia
Eesti Raadio
Eesti Televisioon

Finland
MTV Oy
Oy Yleisradio Ab

France
Grouping of French broadcasters, comprising:
- Télévision Française 1
- France 2
- France 3
- Canal Plus
- Radio France
- Radio France Internationale
- TéléDiffusion de France

Europe 1

Germany
Arbeitsgemeinschaft der öffentlich-rechtlichen Rundfunkanstalten der Bundesrepublik Deutschland (ARD), comprising:
- Bayerischer Rundfunk
- Hessischer Rundfunk
- Mitteldeutscher Rundfunk
- Norddeutscher Rundfunk
- Östdeutscher Rundfunk Brandenburg
- Radio Bremen
- Saarländischer Rundfunk
- Sender Freies Berlin
- Süddeutscher Rundfunk
- Südwestfunk
- Westdeutscher Rundfunk
- Deutsche Welle
- DeutschlandRadio

Zweites Deutsches Fernsehen

Greece
Elliniki Radiophonia – Tileorassi SA

Hungary
Magyar Rádió
Magyar Televízió

Iceland
Ríkisútvarpid

Ireland
Radio Telefís Éireann

Israel
Israel Broadcasting Authority

Italy
RAI–Radiotelevisione Italiana

Jordan
Jordan Radio and Television Corporation

Latvia
Latvijas Valsts Televizija
Latvijas Valsts Radio

Lebanon
Radio Liban / Télé-Liban

Libya
Libyan Jamahiriya Broadcasting

Lithuania
Lietuvos Radijas ir Televizija

Luxembourg
CLT Multi Media
Etablissement de Radiodiffusion Socioculturelle du Grand-Duché de Luxembourg

Former Yugoslav Republic of Macedonia
MKRTV

Malta
Broadcasting Authority – Malta / Public Broadcasting Services Ltd – Malta

Moldova
Teleradio-Moldova

Monaco
Groupement de Radiodiffuseurs monégasques, comprising:
- Radio Monte-Carlo
- Télé Monte-Carlo
- Monte-Carlo Radiodiffusion

Morocco
Radiodiffusion-Télévision Marocaine

Netherlands
Nederlandse Omroep Stichting (NOS), comprising:
- Algemene Omroepvereniging AVRO
- Vereniging de Evangelische Omroep
- Katholieke Radio Omroep
- Nederlandse Christelijke Radio Vereniging
- Nederlandse Programma Stichting
- Omroepvereniging VARA
- Omroepvereniging VPRO
- TROS

Norway
Norsk rikskringkasting
TV 2 AS

Poland
Polskie Radio i Telewizja, comprising:
- Telewizja Polska SA
- Polskie Radio SA

Portugal
Radiodifusão Portuguesa SA
Radiotelevisão Portuguesa SA

Romania
Societatea Româna de Radiodifuziune
Societatea Româna de Televiziune

Russian Federation
Obshchtestvennoe Rossijskoe Televidenie
Radio Dom Ostankino, comprising:
- Radio Mayak
- Radio Orpheus
- Voice of Russia

Rossijskoe Televidenie

San Marino
San Marino RTV

Slovakia
Slovensky Rozlas
Slovenská Televizia

Slovenia
Radiotelevizija Slovenija

Spain
Radiotelevisión Española
Sociedad Española de Radiodifusión

Sweden
Sveriges Television och Radio Grupp, comprising:
- Sveriges Television Ab
- Sveriges Radio Ab
- Sveriges Utbildningsradio Ab

Switzerland
Société Suisse de Radiodiffusion et Télévision

Tunisia
Établissement de la Radiodiffusion-Télévision Tunisienne

Turkey
Türkiye Radyo – Televizyon Kurumu

Ukraine
Natsionalna Radiokompanya Ukraïny
Natsionalna Telekompanya Ukraïny

United Kingdom
British Broadcasting Corporation
United Kingdom Independent Broadcasting, comprising:
Independent Television: The Network Centre, grouping :
- Anglia Television
- Border Television
- Carlton Television
- Central Independent Television
- Channel Television
- Grampian Television
- Granada Television
- HTV
- London Weekend Television
- Meridian Broadcasting
- Scottish Television
- Tyne Tees Television
- Ulster Television
- Westcountry Television
- Yorkshire Television
- Independent Television News

Channel 4, Sianel 4 Cymru
Commercial Radio Companies Association

Vatican State
Radio Vaticana

EBU Associate Members

(last update: January 1998)

Albania
Radiotelevisione Shqiptar

Armenia
Hayastani Azgayin Radio and Hayastani Azgayin Heroustatesoutun

Australia
Australian Broadcasting Corporation
Federation of Australian Commercial Television Stations
Special Broadcasting Service

Bangladesh
National Broadcasting Authority of Bangladesh

Barbados
Caribbean Broadcasting Corporation

Brazil
TV Globo Ltda

Canada
Canadian Broadcasting Corporation

Chile
Corporación de Televisión de la Universidad Católica de Chile
(Canal 13)

Cuba
Instituto Cubano de Radio y Televisión

Greenland
Kalaalit Nunaata Radioa

Hong Kong
Asia Television Ltd
Radio Television Hong Kong
Television Broadcasts Ltd

India
All India Radio

Iran
Islamic Republic of Iran Broadcasting

Japan
Asahi National Broadcasting Co. Ltd
(TV Asahi)
Fuji Television Network Inc
National Association of Commercial Broadcasters in Japan
Nippon Hoso Kyokai
Nippon Television Network Corporation
Tokyo Broadcasting System Inc
Tokyo FM Broadcasting Co. Ltd

Korea (Republic of)
Korean Broadcasting System
Munhwa Broadcasting Corporation

Malawi
Malawi Broadcasting Corporation

Malaysia
Radio Television Malaysia

Mauritius
Mauritius Broadcasting Corporation

Mexico
Televisa SA de CV

Nepal
Nepal Television Corporation

New Zealand
Radio New Zealand
Television New Zealand Ltd

Oman
Oman Directorate General of Radio and Television

Pakistan
Pakistan Television Corporation

South Africa
South African Broadcasting Corporation

Sri Lanka
Sri Lanka Broadcasting Corporation

Syria
Organisme de la Radio-Télévision Arabe Syrienne

United Arab Emirates
Emirates Broadcasting Corporation
United Arab Emirates Radio and Television – Dubai

United States
Capital Cities / American Broadcasting Companies Inc
CBS Inc
Corporation for Public Broadcasting/Public Broadcasting Service / National Public Radio / Public Radio International
National Broadcasting Company Inc
Turner Broadcasting System Inc
United States Information Agency
WFMT

Venezuela
Corporación Venezolana de Televisión CA
Radio Caracas Televisión / Radio Caracas Radio

Zimbabwe
Zimbabwe Broadcasting Corporation

Approved Participants
Antenna Hungária
ARTE
Euronews
Israeli Educational Television
Middle East Broadcasting Centre Ltd
TV5